MacLean
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HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

208A
208A-DB
TEST OSCILLATOR

hp 208A/208A-DB

MANUAL CHANGES

MODEL 208A/208A-DB

TEST OSCILLATOR

Manual Serial Prefixed: 318-
Part No. 00208-90000

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL	ERRATA		
318-	1		

CHANGE #1

Table 6-2, Replaceable Parts:

R80	Was 0687-3331		
	Now 0687-3921	R:	fxd, comp, 3.9 K ohms ±10%, 1/2 w
R105	Was 0687-3921		
	Now 0687-2721	R:	fxd, comp, 2.7 K ohms ±10%, 1/2 w
R106	Was 0698-0001		
	Now 0687-3331	R:	fxd, comp, 33 K ohms ±5%, 1/2 w
R48	Was 0687-3951		
	Now 0687-1051	R:	fxd, comp, 1.0 M ohms ±10%, 1/2 w
C17	Was 0140-0100		
	Now 0140-0004	C:	fxd, 15 pf, 500 v

208A-DB is Now option 01.

ERRATA

Add to Table 6-1, Reference Designation Index, Miscellaneous section:

Circuit Reference: BT101 through BT104, Part No. 0420-0015.
Description: Battery, Nickel Cadmium, 6 v nom, 225 mah.

Add to Table 6-2, Replaceable Parts:

Part No. 1420-0015.
Description: Battery, Nickel Cadmium, 88220 Mfr., Mfr. Part No. 6.0 v/255B, TQ 4, RS 4.

Figure 5-14, Model 208A and 208A-DB Schematic Diagrams:

Change A4C37 to 50 μfd.

Change value of R14 to 18 ohms. (on A2)

Change R18 and R34 to R18* and R34*, value selected at the factory, average value shown. (on A2)

OPERATING AND SERVICE MANUAL

MODEL 208A/208A-DB

SERIALS PREFIXED: 318-

TEST OSCILLATOR

01350-1

Printed: Aug 1963

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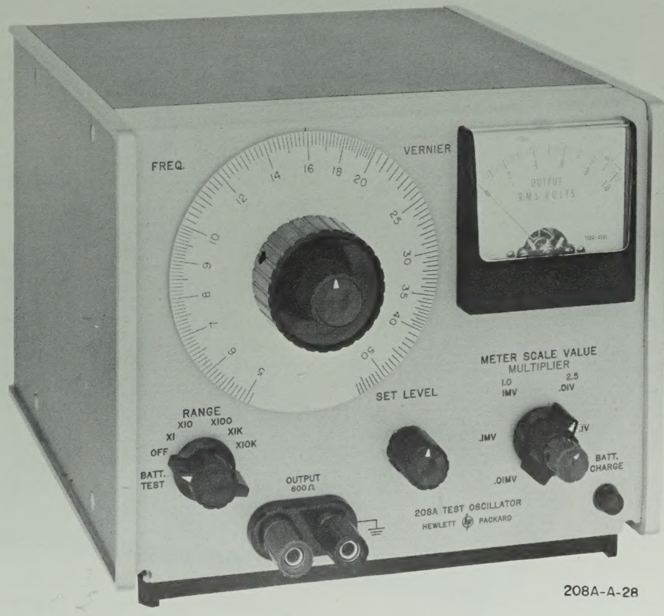


Figure 1-1. Model 208A Test Oscillator

Table 1-1. Specifications

FREQUENCY RANGE:
5 cps to 560 Kc in 5 ranges. 5% overlap between ranges, vernier control.

DIAL ACCURACY: ±3%

FREQUENCY RESPONSE: ±3% into rated load

OUTPUT:
10 milliwatts, nominal 2.5 v rms (+10 dbm) into 600 ohms.

OUTPUT IMPEDANCE: 600 ohms

OUTPUT ATTENUATOR:
Meter Scale Value: 0.01 Mv to 1 volt full scale in 6 steps.
Multiplier: 2.5 multiplier, concentric with Meter Scale Value switch, to obtain 0.025 Mv to 2.5 volts.

OUTPUT ATTENUATOR ACCURACY:
5 cps to 100 Kc, error is less than ±3% at any step. From 100 Kc to 560 Kc, error is less than 5% at any step. Specifications include multiplier accuracy.

OUTPUT MONITOR:
Transistor voltmeter monitors level at input to attenuator and after set level. Accuracy, ±2% of full scale into 600 ohms.

OPERATING TEMPERATURE RANGE: 0°C to $+50^{\circ}$C

SET LEVEL:
Continuously variable bridged "T" Attenuator with 10:1 voltage range.

DISTORTION: Less than 1%

HUM AND NOISE:
Less than .05% at maximum output

POWER SOURCE:
4 rechargeable batteries (furnished). Thirty hour operation per recharge. Oscillator may be operated during recharge from AC line. (115v or 230v ±10%, 50 to 1000 cps, approx. 3 watts).

DIMENSIONS (with feet):
Module 6-1/2" high (16.5 cm) x 7-25/32" wide (19.8 cm) x 8" deep (20.3 cm)

WEIGHT:
8-1/4 pounds (3.5 kg), shipping approximately 10 pounds (4.5 kg).

208A-A-30

Figure 1-2. Model 208A-DB Test Oscillator

Table 1-2. Specifications

FREQUENCY RANGE:
5 cps to 560 Kc in 5 ranges. 5% overlap between ranges, vernier control.

DIAL ACCURACY: ±3%

FREQUENCY RESPONSE: ±3% into rated load

OUTPUT:
10 milliwatts, nominal (+10 dbm) into 600 ohms

OUTPUT IMPEDANCE: 600 ohms

OUTPUT ATTENUATOR: 0 to 110 db in 1 db steps

ACCURACY, 10 DB SECTION:
From 5 cps to 100 Kc, error is less than ±0.125 db at any step. From 100 Kc to 560 Kc, error is less than ±0.25 db at any step.

ACCURACY, 100 DB SECTION:
From 5 cps to 100 Kc, error is less than ±0.25 db at any step. From 100 Kc to 560 Kc, error is less than ±0.5 db at any step.

OPERATING TEMPERATURE RANGE:
$0^{\circ}C$ to $+50^{\circ}C$

OUTPUT MONITOR:
Transistor voltmeter monitors level at input to attenuator, and after set level. Scale calibrated from -10 dbm to +11 dbm. Accuracy, ±0.25 db at +10 DBM into 600 ohms.

SET LEVEL:
Continuously variable bridged "T" Attenuator with 20 db minimum range.

DISTORTION: Less than 1%

HUM AND NOISE:
Less than .05% at maximum output

POWER SOURCE:
4 rechargeable batteries (furnished). Thirty hour operation per recharge. Oscillator may be operated during recharge from AC line (115 v or 230 v ±10%, 50 to 1000 cps, approx., 3 watts).

DIMENSIONS (with feet):
Module 6-1/2" (16.5 cm) high x 7-25/32" (19.8 cm) wide x 8" (20.3 cm) deep.

WEIGHT:
8-1/4 pounds (3.5 kg), shipping approximately 10 pounds (4.5 kg).

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 208A or Model 208A-DB Test Oscillator is a precision resistance tuned oscillator, covering a frequency range from 5 cps to 560 Kc. It has a stable output signal that is adjustable from 5 microvolts to 2.5 volts. Frequency response is essentially flat (±3%) into a rated load of 600 ohms throughout the complete frequency range. There is excellent frequency stability even in rapidly changing loads; frequency stability is typically better than 5 parts 10^4. Short term stability over a few minutes at constant temperature is typically better than 0.001% at 400 cycles per second.

1-3. This solid state Model 208A/208A-DB Test Oscillator is a versatile general purpose audio oscillator for use in laboratories and production and is ideal for field work since it is transistorized and battery operated. It is versatile because of its wide frequency range, exceptional stability and portability. Measurements may be made nearly anywhere since the Model 208A/208A-DB is completely self-contained and operated either from its internal batteries or from the AC line. Battery charge, which is automatically restored during AC operation may be easily checked with a front panel switch to assure you of reliable measurements. Normally about 60 hours of AC operation recharges the batteries but an internal adjustment is provided which nearly doubles the charging rate. The Model 208A/208A-DB may be used while its batteries are charging.

Note

The Model 208A/208A-DB will not function with the batteries removed from the instrument.

1-4. MODEL 208A.

1-5. Stable accurate signals are instantly available from 5 cycles per second to 560 Kc. Output voltages are adjustable between 5 microvolts and 2-1/2 volts. The output voltage is monitored by a transistorized voltmeter circuit which measures the rms voltage at the input to the attenuator system. The output voltage is the meter scale value multiplied by the indication on the output monitor and multiplied by the attenuator (multiplier). The output attenuator is adjustable in 20 db steps and maximum attenuation is 100 db. The voltage applied to the output attenuator is set with a set level control which provides continuous control between the 20 db steps of attenuation. The attenuator output voltage is correct when the output terminals are terminated into 600 ohms.

1-6. MODEL 208A-DB.

1-7. Stable accurate signals are instantly available over a frequency range from 5 cycles per second to 560 Kc. Output levels are adjustable between +10 dbm and -118 dbm. The output level is monitored by a transistorized voltmeter circuit which measures the rms voltage at the input to the attenuator system. This output monitor is calibrated in dbm. The output level is the indication on the output monitor in dbm multiplied by the setting of the attenuator. The output attenuator is adjustable in one db steps, and maximum attenuation is 110 db. The level applied to the output attenuator is set with a set level control which provides continuous control between the 1 db or 10 db steps on the 110 db attenuator. The attenuator output level is correct when the output terminals are terminated into 600 ohms.

1-8. USES.

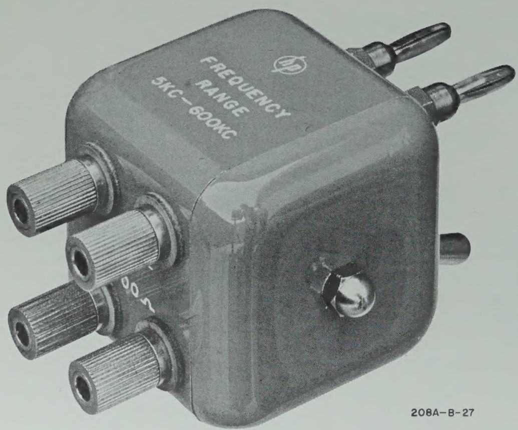
1-9. The ⓗⓟ Model 208A/208A-DB has a multitude of uses. This Test Oscillator was designed for such applications as fast and accurate testing of filter transmission characteristics, receiver alignment, telephone carrier measurements, testing television amplifiers, wide band systems and network measurements. It is an excellent audio oscillator for laboratory or field measurements, and provides known attenuation for voltmeters. The Model 208A/208A-DB used in conjunction with ⓗⓟ accessories 11004A and 11005A Line Transformers will provide a balanced output, and can be used for transmission line, attenuation, frequency response and gain measurements. It is also useful for the maintenance of multi-channel communication systems.

1-10. DIFFERENCES BETWEEN INSTRUMENTS.

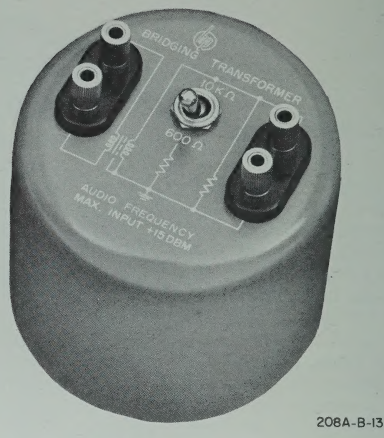
1-11. The Model 208A/208A-DB carries a five-digit serial number with a three-digit prefix (000-00000). The prefix is an identifier, and it appears on the title page of this manual to indicate to which instrument this manual directly applies. A supplement sheet may be included with this manual indicating the necessary changes to make it apply directly to Models 208A/208A-DB which carry a different serial number prefix.

1-12. ACCESSORIES AVAILABLE.

1-13. Table 1-3 and Figure 1-3 illustrate accessories which are made by Hewlett-Packard to increase the usefulness of your Test Oscillator.



Model 11004A Line Matching Transformer



Model 11005A Bridging Transformer

Figure 1-3. Accessories

Table 1-3. Accessories Available

Model No.	Use	Features
11004A	Line Matching Transformer Provides balanced 135 or 600 ohm input to 600 ohm unbalanced output for measurements on balanced lines	Terminating Resistance: 600 or 10K ohms Frequency Range: 5 to 600 Kc Power Handling Capacity: ±22 DBM (10 v into 600 ohms) Balance: Better than 40 db entire frequency range
11005A	Line Bridging Transformer Provides balanced 600 ohm input to unbalanced 600 ohm output for measurements on balanced lines	Terminating Resistance: 600 or 10K ohms Frequency Range: 20 cps to 45 Kc Power Handling Capability: +15 DBM (4.5 v into 600 ohms)
353A (not shown)	Patch Panel Provides balanced 135, 600 or 900 ohm input to unbalanced 600 ohm output for measurements on balanced lines.	Input: (Receiver) Frequency Range: 50 cps to 560 Kc Balance: Better than 70 db at 60 cps for 600 and 900 Ω Better than 60 db at 1 Kc for 600 and 900 Ω Better than 40 db over entire frequency range for 135, 600 and 900 ohms Frequency Response: ±1/2 db, 50 cps to 560 Kc Impedance: 135, 600, 900 ohms and Bridging (10K) center tapped Insertion Loss: Less than 3/4 db at 1 Kc Maximum Level: +20 DBM (10 v RMS at 600 ohms) Output: (Source) Frequency Range: 50 cps to 560 Kc Balance: Better than 70 db at 60 cps for 600 and 900 Ω Better than 60 db at 1 Kc for 600 and 900 Ω Better than 40 db over entire frequency range for 135, 600 and 900 ohms Frequency Response: ±1/2 db, 50 cps to 560 Kc Impedance: 135, 600, and 900 ohms center tapped Insertion Loss: Less than 3/4 db at 1 Kc Distortion: Less than 1%, 50 cps to 560 Kc Maximum Level: +29 DBM (10 v RMS at 600 ohms)
11000A 11001A	Test Leads	Dual Banana Plug Banana Plug to BNC Male Connector

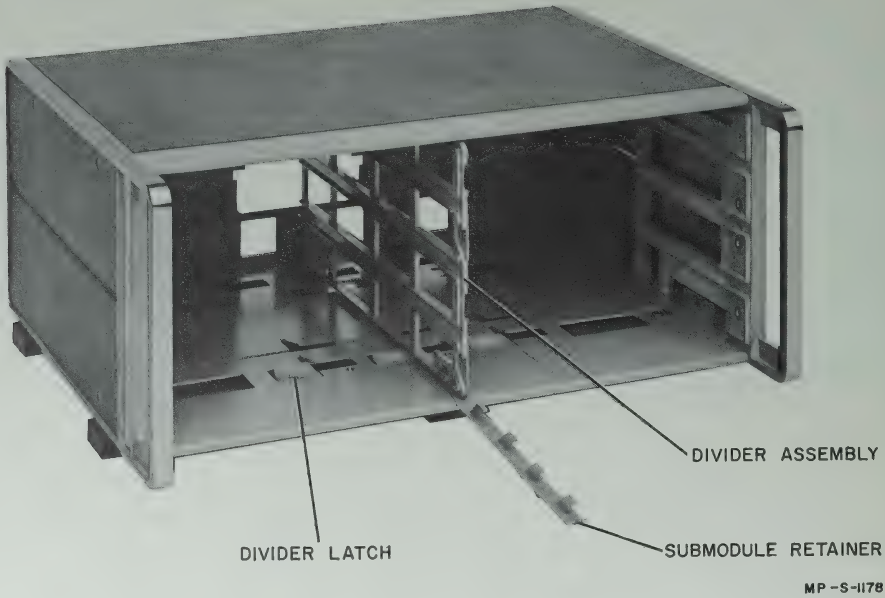


Figure 2-1. The Combining Case

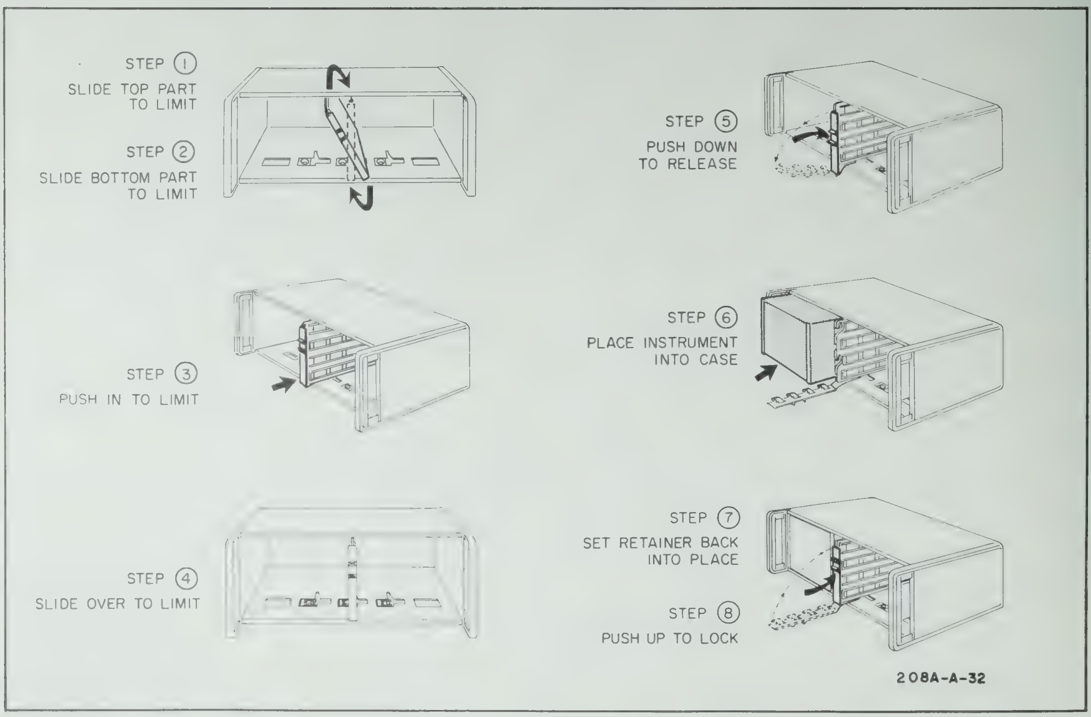


Figure 2-2. Steps to Place Instrument into Combining Case

SECTION II
INSTALLATION

2–1. INSPECTION.

2-2. Unpack the instrument upon receipt and inspect it for signs of physical damage such as scratched panel knobs, etc. If there is any apparent damage, file a claim with the carrier and refer to the warranty page on the back of this manual.

2-3. An electrical inspection should be performed as soon as possible after receipt. To aid in electrical inspection, performance checks are included in section V, Paragraph 5-29.

2–4. POWER REQUIREMENTS.

2-5. The Model 208A / 208A - DB operates on nickel cadmium batteries. This instrument uses four 6. 5 volt cells and, under continuous operation over 30 hours of service is obtained from the batteries before recharging. The Model 208A/208A-DB can be operated on 115 or 230 volts AC. This instrument is continually charging the batteries whenever the line cord is connected to a 115 or 230 volt source.

CAUTION

A switch located on the rear of the instrument enables the user to select the 115 or 230 volt position when applying AC power to this instrument.

2–6. INSTALLATION.

2-7. The ⓗⓟ Model 208A/208A-DB is fully transistorized; therefore no special cooling is required. However, the AC power should not be used where the ambient temperature exceeds 40° C (104° F). See Paragraph 4-42.

2–9. RACK MOUNTING.

2-9. The Model 208A/208A-DB is a submodular unit that when used alone can be bench mounted only. However, when used in combination with other submodular units it can be bench and/or rack mounted. The ⓗⓟ combining case and adapter frame are designed specifically for this purpose.

2-10. COMBINING CASE. The combining case is a full-module unit which accepts varying combinations of submodular units. Being a full-module unit, it can be bench or rack mounted analogous to any full-module instrument. An illustration of the combining case is shown in Figure 2-1. Instructions for installing the Model 208A/208A-DB in a combining case is given graphically in Figure 2-2.

2-11. ADAPTER FRAME. The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. An illustration of the adapter frame is given in Figure 2-3.

2–12. REPACKING FOR SHIPMENT.

2-13. When returning an instrument to the Hewlett-Packard Company, use the original packing material (only if foam type) if available or contact your Hewlett-Packard field office for assistance. If this is not possible, first protect the instrument surfaces with sheets of cardboard flat against the instrument. Then protect the instrument on all sides (use approximately 4 inches of packing material designed specifically for package cushioning), pack in a durable carton, mark carton clearly for proper handling, and insure adequately before shipping. Original packing material which is a cardboard "accordion - like" filler is not recommended for reshipment since the cushioning ability is usually destroyed with one use.

2-14. When returning an instrument to the Hewlett-Packard Company for service or repair, attach a tag to the instrument specifying the owner and desired action. All correspondence should identify the instrument by model number and full serial number.

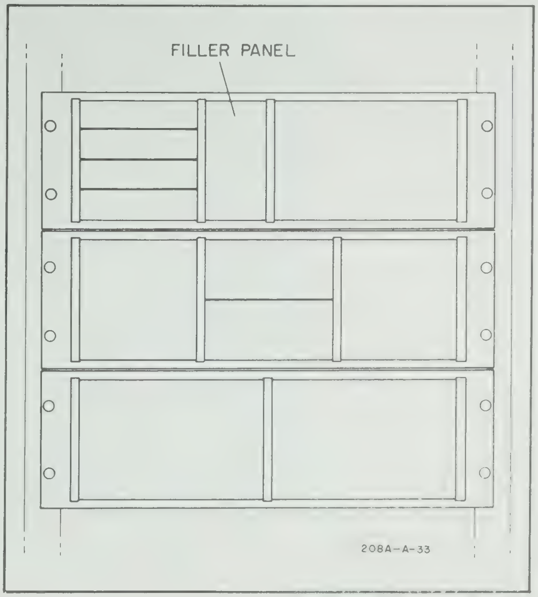


Figure 2-3. Adapter Frame Instrument Combinations

Table 3-1. Model 208A/208A-DB Matching Network Values

Ƶ (ohms)	Z (ohms)	U (ohms)	V (ohms)	W (ohms)	Insertion Loss
600	50	574.5	2.111	49.92	17 db
600	200	489.9	.9824	243.4	10 db
600	500	245.2	13.22	1148.0	4 db
600	2000	33.06	1674.0	670.8	11 db
600	5000	3.232	4690.0	636.2	15 db

3-20. ATTENUATOR (208A-DB).

3-21. This rotary switch is the output attenuator which provides attenuation of the signal level in 1 db or 10 db steps to a maximum attenuation of 110 db. This attenuator has two sections, (1) 100 db, adjustable in 10 db steps, and (2) 10 db, adjustable in 1 db steps. The two sections combine to allow setting of 1 db increments over the full 110 db range. The output of this attenuator is connected directly to the OUTPUT terminals of this Test Oscillator

3-22. MATCHED IMPEDANCE (208A-DB).

3-23. When the Model 208A-DB OUTPUT terminals are terminated by 600 ohms, attenuation is the sum of 10 db and 100 db control settings. The voltage at the output may be determined by the front panel meter reading and the amount of attenuation inserted by the 110 db attenuator. A typical example in finding voltage at the OUTPUT terminals is illustrated in steps a through c.

a. Adjust the SET LEVEL control for a +10 dbm indication on the panel meter, and determine the amount of attenuation set on the Model 208A-DB.

Note

+10 dbm = 2.45 volts

b. Locate the amount of attenuation in the db column of Table 3-2 and read the corresponding attenuation factor.

c. To calculate the output voltage, multiply the meter reading (converted to voltage) by the attenuation factor. See Paragraph 3-24 for an example.

3-24. When the Model 208A-DB is connected to a matching load, and is set to attenuate the signal by 24 db, the attenuation factor for 24 db from Table 3-2 is 0.0631 and the output voltage, for the conditions shown is then:

$$V_{out} = 2.45\ (0.0631) = .154 \text{ volts}$$

3-25. NEED FOR OUTPUT MATCH. To maintain the rated attenuation accuracy of the Model 208A/208A-DB the impedance of the load must match the output impedance of the Model 208A/208A-DB. When the load across the Test Oscillator must be terminated in its matching impedance, a resistive matching network can be used. When mismatch does not affect the load, under some conditions the required impedance match for the Model 208A-DB can be obtained by use of a single resistor. Conditions under which a resistor can be used in matching networks are discussed below:

3-26. MIS-MATCHED IMPEDANCE.

a. When the impedance of the load is less than 600 ohms and the load is not affected by a mismatch, impedance match for the Model 208A/208A-DB output can be obtained by inserting a series resistor between the Model 208A/208A-DB output and load. The resistive value should be the difference between 600 ohms and the load impedance.

b. When the impedance of the load is much higher than 600 ohms on the order of 50,000 ohms or more, impedance match for the Model 208A/208A-DB can be obtained by using a 600 ohm shunting resistor across the output.

c. Networks may be used which provide the Model 208A/208A-DB and its load with an impedance match. Network data and connections are given in Figure 3-2 and Table 3-1.

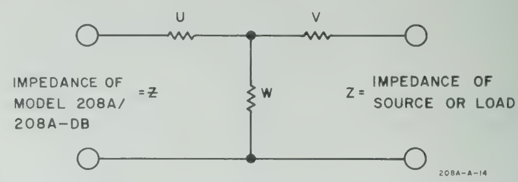


Figure 3-2. Network Data

3-27. The 600 ohm output terminals are universal binding posts on 3/4 inch centers with one terminal marked with a ground symbol which designates this terminal is grounded to instrument chassis.

3-28. BALANCED OUTPUT.

3-29. The Hewlett-Packard accessories Model 11004A and Model 11005A Line Matching Transformer and Bridging Transformer (optional equipment) are specially designed to connect a balanced system to hp Model 200 series Audio Oscillators. The 11004A transformer has a frequency response between 5 Kc and 600 Kc providing fully balanced output for a 135 or 600 ohm balanced line. The 11005A Transformer has a frequency response between 20 cps to 45 Kc providing fully balanced output for a 600 ohm balanced line.

3-30. The Model 208A/208A-DB will provide fully balanced output when used in conjunction with the Model 11004A or 11005A Transformers. Figure 3-3 illustrates the Balanced Line Configuration between the frequency range 20 cps to 15 Kc, and Figure 3-4 illustrates Balanced Line Configurations between the frequency range 5 Kc to 600 Kc.

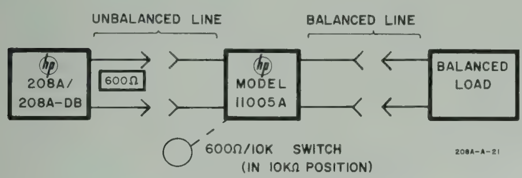


Figure 3-3. 600 Ohm Balanced Line Configurations

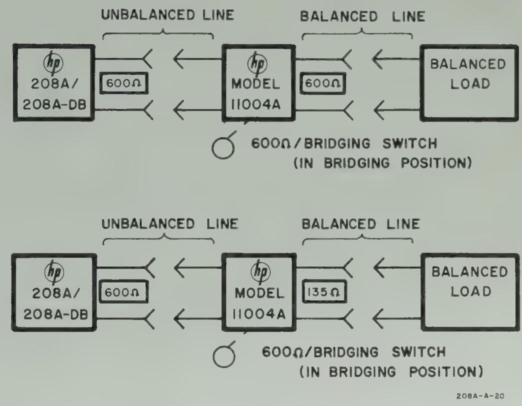
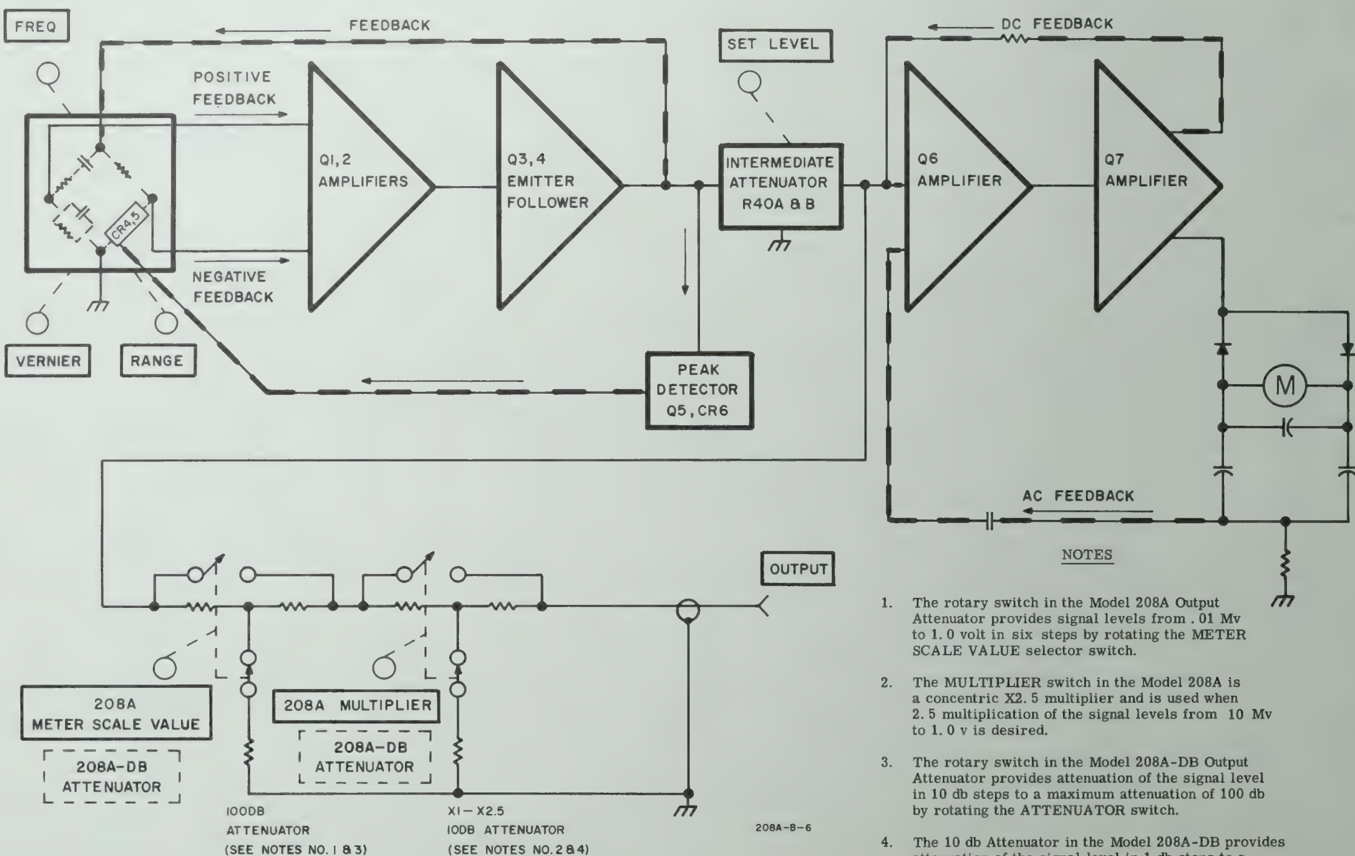


Figure 3-4. 135 Ohm or 600 Ohm Balanced Line Configurations

Table 3-2. Attenuation Factors

db	Attenuation Factor, A_f	db	Attenuation Factor, A_f	db	Attenuation Factor, A_f
0	1.0000	37	.01413	74	.0001995
1	.8913	38	.012590	75	.0001778
2	.7943	39	.011220	76	.00015850
3	.7079	40	.010000	77	.00014130
4	.6310	41	.008913	78	.00012590
5	.5623	42	.007943	79	.00011220
6	.5012	43	.007079	80	.00010000
7	.4467	44	.006310	81	.00008913
8	.3981	45	.005623	82	.00007943
9	.3548	46	.005012	83	.00007079
10	.3162	47	.004467	84	.00006310
11	.2818	48	.003981	85	.00005623
12	.2512	49	.003548	86	.00005012
13	.2239	50	.003162	87	.00004467
14	.1995	51	.002818	88	.00003981
15	.1778	52	.002512	89	.00003548
16	.1585	53	.002239	90	.00003162
17	.1413	54	.001995	91	.00002818
18	.1259	55	.001778	92	.00002512
19	.1122	56	.001585	93	.00002239
20	.1000	57	.001413	94	.00001995
21	.08913	58	.001259	95	.00001778
22	.07943	59	.001122	96	.00001585
23	.07079	60	.001000	97	.00001413
24	.06310	61	.0008913	98	.00001259
25	.05623	62	.0007943	99	.00001122
26	.05012	63	.0007079	100	.00001000
27	.04467	64	.0006310	101	.000008913
28	.03981	65	.0005623	102	.000007943
29	.03548	66	.0005012	103	.000007079
30	.03162	67	.0004467	104	.000006310
31	.02818	68	.0003981	105	.000005623
32	.02512	69	.0003548	106	.000005012
33	.02239	70	.003162	107	.000004467
34	.01995	71	.0002818	108	.000003981
35	.01778	72	.0002512	109	.000003548
36	.01585	73	.0002239	110	.000003162



NOTES

1. The rotary switch in the Model 208A Output Attenuator provides signal levels from .01 Mv to 1.0 volt in six steps by rotating the METER SCALE VALUE selector switch.

2. The MULTIPLIER switch in the Model 208A is a concentric X2.5 multiplier and is used when 2.5 multiplication of the signal levels from 10 Mv to 1.0 v is desired.

3. The rotary switch in the Model 208A-DB Output Attenuator provides attenuation of the signal level in 10 db steps to a maximum attenuation of 100 db by rotating the ATTENUATOR switch.

4. The 10 db Attenuator in the Model 208A-DB provides attenuation of the signal level in 1 db steps to a maximum attenuation of 10 db.

Figure 4-1. Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4—1. INTRODUCTION.

4-2. The Model 208A / 208A-DB consists of an RC bridge oscillator circuit, a 110 db attenuator adjustable in 1 db steps (Model 208A-DB) and a metering circuit. These circuits and the front panel controls associated with them are shown in the block diagram, Figure 4-1.

4-3. Referring to Figure 4-1, the RC bridge oscillator consists of an RC bridge, a two-stage amplifier, and two emitter followers. This RC bridge consists of an RC frequency selective network and a resistive voltage divider network. The RC frequency selective network supplies positive feedback to the amplifier and determines the frequency of oscillation. The resistive voltage divider network supplies negative feedback to the amplifier. The output of the amplifier is proportional to the difference between the feedback signals.

4-4. The peak detector detects changes in the RC bridge oscillator output voltage, and changes the division ratio of the resistive voltage divider network which changes the amount of negative feedback to the oscillator. The peak detector in conjunction with the divider network maintains the amplitude of the RC oscillator within ±3% of a constant level.

4-5. The variable attenuator (SET LEVEL CONTROL) is a bridged-T attenuator which provides at least 20 db control of the oscillator output voltage while maintaining constant output voltage (600 ohms).

4-6. The Model 208A 100 db attenuator is a 600 ohm bridged-T attenuator which provides attenuation up to 100 db in 20 db steps, with a concentric 2. 5 multiplier used to obtain maximum output from the oscillator.

4-7. The Model 208A-DB, 110 db attenuator is a 600 ohm bridged-T attenuator which provides attenuation in 1 db or 10 db steps to a maximum attenuation of 110 db.

4-8. The Model 208A metering circuit is a transistorized voltmeter which indicates the rms voltage at the input of the output attenuator.

4-9. The Model 208A-DB output level monitored by a transistorized voltmeter circuit which measures the rms voltage at the input of the output attenuator. This output meter is calibrated in dbm.

4—10. OSCILLATOR CIRCUIT.

4-11. The RC bridge in the oscillator circuit consists of an RC frequency selective network and a resistive voltage divider network. Referring to Figure 4-2 (Simplified Schematic Diagram) you will notice the frequency selective network together with the resistive divider leg comprise a Wein bridge configuration.

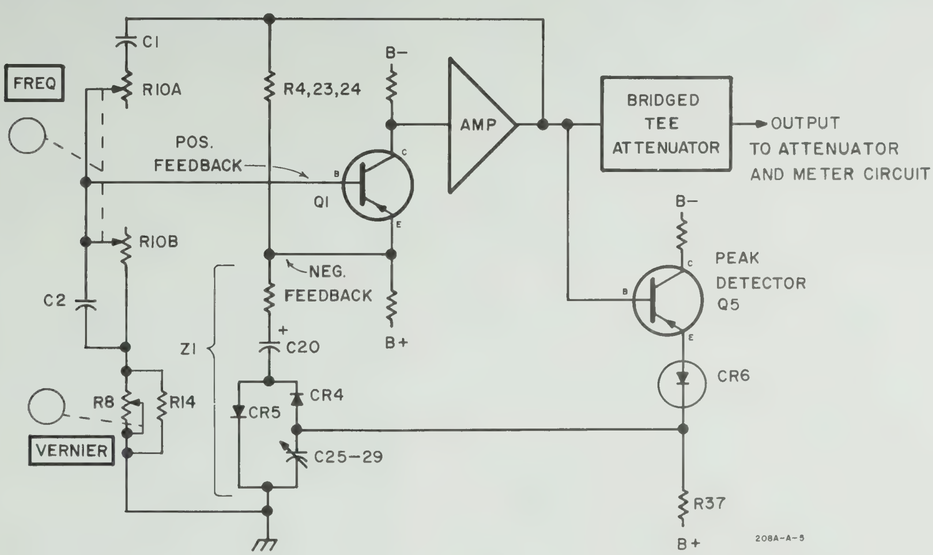


Figure 4-2. Simplified Oscillator Circuit

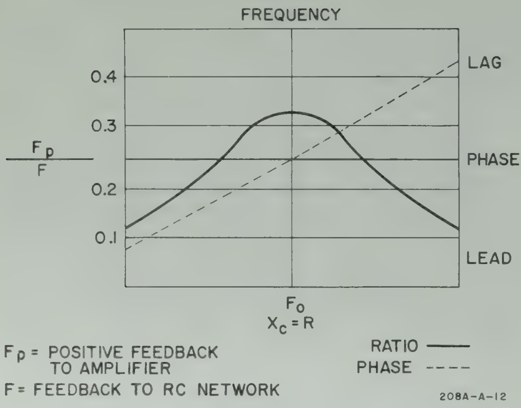


Figure 4-3. RC Network Characteristics

4-12. Oscillations are maintained by applying a positive feedback signal from the oscillator output circuit back to the Wein bridge network. The proper phase relationship at the desired frequency is maintained by the RC components in the bridge. The main frequency-tuning elements are variable resistances R10A and R10B while capacitors C1 and C2 are changed to establish various ranges. The tuning resistances are driven through a drive system which give a logarithmic frequency dial. The vernier control R8 provides for fine tuning and insures infinite frequency resolution without altering the output signal voltage level. The vernier control has a minimum range of .15%.

4-13. The frequency selective network is in the positive feedback arms of this bridge which is formed by C1 and R10A in series and C2 and R10B in parallel with each other. When $X_c = R$ in the series and parallel branches, the positive feedback voltage to the amplifier is maximum and in phase with the oscillator circuit output voltage (refer to Figure 4-3). Only at the frequency where $X_c = R$, will the signal be amplified; at frequencies where X_c does not equal R the positive feedback voltage is not of the right phase and is insufficient in amplitude to sustain oscillation. Figure 4-3 shows the positive feedback curve and phase relationship for frequencies above and below the frequency where $X_c = R$.

4-14. Referring to Figure 4-2 the negative feedback arms are formed by R4, 23, 24 and network Z1. This resistive voltage divider network provides negative feedback voltage to maintain the oscillator output at a constant level. This negative feedback is developed by the voltage drop across the dynamic resistance of CR4 and CR5. This diode resistance is controlled by the Q5 and CR6 forward bias applied to CR4 and CR5 supplied by the peak detector circuit. Diode CR6 establishes a reference voltage which is compared to the amplitude of oscillation at the output stage Q3 and Q4. An error voltage is developed which is fed back to control the resistance of the forward biased diodes CR4 and CR5. These in turn affect the total impedance of Z1 in such a way to maintain the proper amplitude of oscillations. For example, if the oscillator circuit output voltage were to increase, the peak detector circuit would decrease the forward bias on CR4 and CR5, increasing the diodes dynamic resistance. Increased impedance of Z1 of the divider increases the amount of negative feedback to the emitter of the amplifier Q1. Increasing the negative feedback to Q1 results in a reduced output from Q1, which will compensate for the original increase in oscillator output voltage.

4–15. OUTPUT CIRCUIT.

4-16. The oscillator output circuit is maintained at a constant amplitude of 14 volts peak to peak. Two amplifiers, Q1 and Q2 (refer to Schematic Diagram, Figure 5-14) amplify the signal and apply it to emitter followers Q3 and Q4. The emitter followers are forward biased by diodes CR2 and CR3 and under a no-signal condition are conducting slightly to minimize crossover distortion. The oscillator output is sampled by the peak detector, and also coupled to the intermediate attenuator.

4–17. PEAK DETECTOR.

4-18. The Peak Detector mentioned in the Oscillator Circuit and Output Circuit consists of Q5 and CR6. This circuit samples the oscillator circuit output, and supplies bias proportional to the output signal to control the dynamic resistance of the diodes in the resistive voltage divider network. Transistor Q5 conducts only when the negative peak of the output signal exceeds (-7) volts. When this occurs the breakdown diode CR6 conducts and the voltage at the junction of CR6 and C25 through C29 decreases. This changes the bias to CR4 and CR5, which affects the resistance of these diodes. Capacitors C25 through C29 act to average the bias voltage applied to the diodes over the period of one cycle.

4–19. INTERMEDIATE ATTENUATOR.

4-20. The output of the oscillator is fed to the intermediate attenuator. This attenuator is a bridged-T type attenuator that is variable over a 20 db range by the SET LEVEL front panel control. The signal at this point travels to the voltmeter circuit and to the output attenuator.

4–21. VOLTMETER CIRCUIT.

4-22. Referring to Figure 5-14, the output signal is applied to a 10 to 1 voltage divider R43, R44 and R45. Variable resistor R45 (400 cycle CAL) adjustment control is used to adjust the amplitude of the oscillator's signal, applied to the base of Amplifier Q7. Variable capacitor C34 (560 Kc CAL) trimmer compensates for small variations in circuit capacity so the voltmeter will have a flat frequency response.

4-23. Transistors Q6 and Q7 make up a fixed gain amplifier which is used to develop the current for full scale meter deflection and to provide the meter circuit with a high impedance source for linear operation at all current levels. The signal is applied to the base of Amplifier Q6 where it is compared with an AC nega-

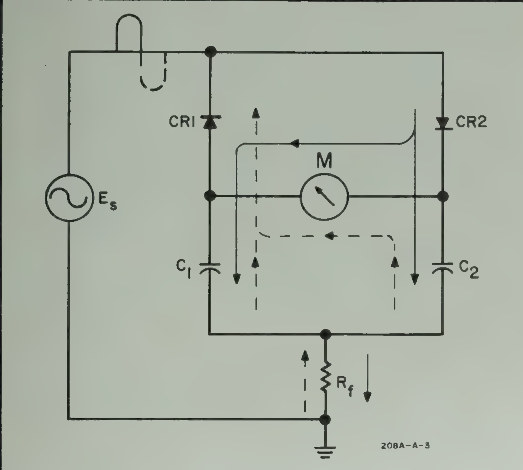


Figure 4-4. Simplified Meter Rectifier Circuit

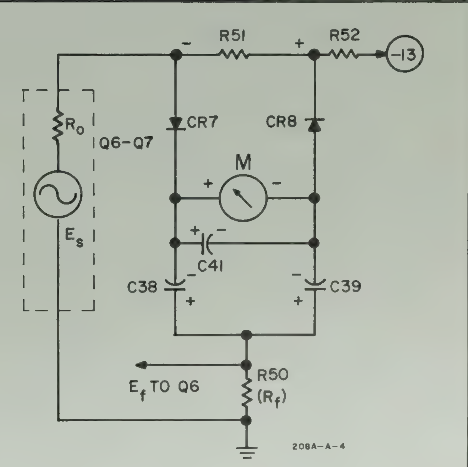


Figure 4-5. Actual Meter Rectifier Circuit

tive feedback signal on its emitter from the meter circuit. The amplified resultant difference signal is fed to Q7. Resistor R48 provides a DC feedback path which improves the bias stability on the base of Q6 and also tends to minimize any tendency for DC drift due to ambient temperature change.

4—24. METER RECTIFIER CIRCUIT.

4-25. The meter rectifier circuit is fed by Amplifier Q7. Resistor R51 impresses a fixed bias across diodes CR1 and CR2, biasing them close to their contact potential, minimizing changes of diode resistance to keep the load resistance of the meter circuit constant. This action enhances voltmeter operation by insuring the change in meter current is proportional to a change in amplifier input voltage.

4-26. The meter rectifier circuit is arranged in a bridge type configuration with a crystal diode in each upper branch and a DC microammeter connected across its midpoints. The current throughout the meter is proportional to the average value of the input voltage.

4-27. The Model 208A/208A-DB meter rectifier circuit operation can best be explained by examining the circuit in a simplified form. Figure 4-4 shows a voltage source generating a voltage E_s across a circuit made up of CR1, CR2, M, R_f and $C_1 C_2$. Note that the current flowing for each half cycle (as indicated by the arrows) always passes through the meter in the same direction.

4-28. In this circuit, disregarding contact potential and assuming zero meter resistance, the circuit could be considered as a small resistance made up of CR1 and CR2 in series with one capacitor ($C_1 + C_2$) in series with R_f. Therefore, there will be a voltage across R_f proportional to the input signal.

4-29. In the actual Model 208A/208A-DB meter rectifier circuit, Capacitors C38 and C39 provide a path for the AC feedback loop. The generator (Q6 - Q7) with its large internal impedance (R_o) develops a voltage across R_f. The meter is deflected according to the average value of the input voltage and is calibrated to indicate the rms value of a sine wave. The signal across R50 as shown in Figure 4-5 provides negative feedback, resulting in extremely linear meter operation.

4—30. OUTPUT ATTENUATOR.

4-31. The Model 208A/208A-DB attenuator is shown in simplified schematic form in Figure 4-6. In the Model 208A-DB attenuator schematic (Figure 5-12), please note that each attenuator section, 10 db and 100 db, is composed of four segments, each basically the same configuration as shown in Figure 4-6. In the Model 208A attenuator schematic (Figure 5-14), please note that the 100 db section is composed of five segments, all basically the same configuration as shown in Figure 4-6.

4—32. ATTENUATOR EXPRESSED IN DECIBLES.

4-33. <u>POWER AND VOLTAGE RATIOS.</u>

4-34. 0 dbm by definition is 1 milliwatt into 600 ohms.

$$\text{Since } \frac{E^2}{R} = \text{Power (Watts)}$$

$$E = \sqrt{1 \text{ Mw} \times 600} = .775 \text{ volts}, \qquad 0 \text{ dbm} = 0.775 \text{ volts}$$

4-35. The basic equation for computing attenuation in decibels is based on a power ratio where P = power, V = voltage, and R = resistance:

$$\text{No. of decibels} = 10 \log_{10} \frac{P_1}{P_2} \qquad (1)$$

(Subscripts (1) and (2) denote attenuator input and output terminals, respectively.)

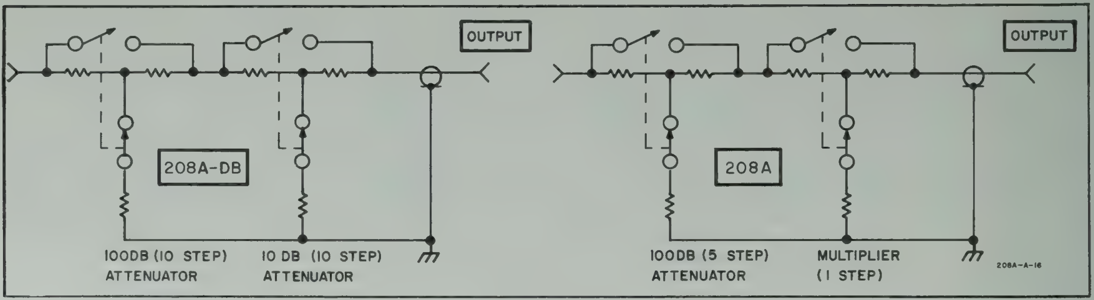


Figure 4-6. Simplified Attenuator Schematic

Since power is expressed as: $P = \frac{V^2}{R}$ (2)

Equation (1) may be rewritten as:

$$\text{no. of db} = 10 \log_{10} \left(\frac{\frac{V_1^2}{R_1}}{\frac{V_2^2}{R_2}} \right) \quad (3)$$

and if $R_1 = R_2$ then,

$$\text{no. of db} = 10 \log_{10} \left(\frac{V_1^2}{V_2^2} \right) \quad (4)$$

The basic rules for exponents of logarithms-then allow equation (4) to be written as:

$$\text{no. of db} = 20 \log_{10} \left(\frac{V_1}{V_2} \right) \quad (5)$$

4-36. The values of attenuation factor given in Table 3-2 are based on a voltage ratio assuming the resistance at the input and output is the same. Values for A_f are computed using equation (5) where $V_1 = V_{in}$ and $V_2 = V_{out}$.

$$V_{out} = V_{in} A_f \quad \text{or} \quad \frac{V_{in}}{V_{out}} = \frac{1}{A_f} \quad (6)$$

Then substituting equation (6) in equation (5) gives

$$\text{no. of db} = 20 \log_{10} \left(\frac{1}{A_f} \right) \quad (7)$$

Solving for A_f gives

$$A_f = \frac{1}{\text{antilog}_{10} \frac{\text{no. of db}}{20}} \quad (8)$$

An example will check the value for A_f given in Table 3-2 illustrating 24 db

$$A_f = \frac{1}{\text{antilog}_{10}\left(\frac{24}{20}\right)} = \frac{1}{\text{antilog}_{10}(1.2)} \quad (9)$$

From a log table, the antilog_{10} of 1.2 is 15.85 and

$$A_f = \frac{1}{15.85} = 0.0631 \quad (10)$$

4-37. REFERENCE FOR DB.

4-38. The db levels given in Figure 3-2 are referenced to a milliwatt of power, hence the term dbm. This indicates that the logarithm is taken of a power ratio where 1 milliwatt is the reference. For 37 dbm equations (1) and (2) show that:

$$\text{dbm} = 10 \log_{10} \frac{\left(\frac{50^2}{500}\right)}{1 \text{ milliwatt}}$$

$$\text{dbm} = 10 \log_{10}(5000) = 10 \quad (0.37) = 3.7$$

4-39. POWER SUPPLY.

4-40. The Model 208A/208A-DB operates on batteries only. When the Model 208A/208A-DB is connected to an AC source the batteries are charging. These instruments use four 6.5 volt nickel-cadmium batteries and are designed to have a battery life of 30 hours before recharging.

4-41. Resistor R102 has been adjusted at the factory for a charging rate of 5.5 Ma to prolong battery life. If the instrument is used frequently in the field, R102 can be adjusted for a charging rate of 11 Ma.

CAUTION

If R102 is adjusted to the 11 Ma rate, this instrument should be used on BATTERIES ONLY except when recharging batteries. Recharging of batteries is accomplished whenever the Model 208A/208A-DB is connected to an AC source. The battery life of the instrument can be prolonged at the 11 Ma charging rate if the instrument is not continuously overcharged.

4-42. When the RANGE switch is in the BATT. TEST position and the instrument indicates below the lower BATT. TEST mark on the OUTPUT MONITOR--recharge the batteries 30 hours at the 11 Ma rate to completely recharge the batteries in the instrument. To conserve battery life do not charge batteries over 30 hours;when R102 is adjusted to the 11 Ma rate.

CAUTION

The four nickel-cadmium batteries in the ⓗⓟ Model 208A / 208A-DB are in hermetically sealed containers. The user must be aware of temperature extremes while charging the batteries. Under high temperatures (above 50^{o} C) hydrogen in the hermatically sealed battery container can build up large pressure causing damage to the batteries and/or instrument. DO NOT CHARGE BATTERIES ABOVE 40^{o} CENTIGRADE or 104^{o} FAHRENHEIT, if R39 is set above 11 Ma charging rate. DO NOT DISCARD BATTERIES IN A FIRE.

4-43. When the RANGE switch is in the BATT. TEST position and the Test Oscillator indicates below the lower BATT. TEST mark on the OUTPUT MONITOR, recharge the batteries 60 hours at 5.5 Ma rate to completely recharge the batteries in the instrument.

4-44. Figure 5-13 illustrates the power supply used in the Model 208A/208A-DB. For 115 volt operation the power transformer primaries are connected in parallel; for 230 volt operation they are connected in series. The rectifier circuit is a conventional full wave bridge using C101 for a filter capacitor. Diode CR105 (7 volt breakdown diode) and Q101 make up a Constant Current Generator. The collector current of Q101 is equal to the voltage across CR105 divided by R102 and R103.

4-45. CR106 prevents the batteries from discharging through to the charging circuit when the instrument is not connected to an AC source. R102 is used to control the amount of current to charge the batteries.

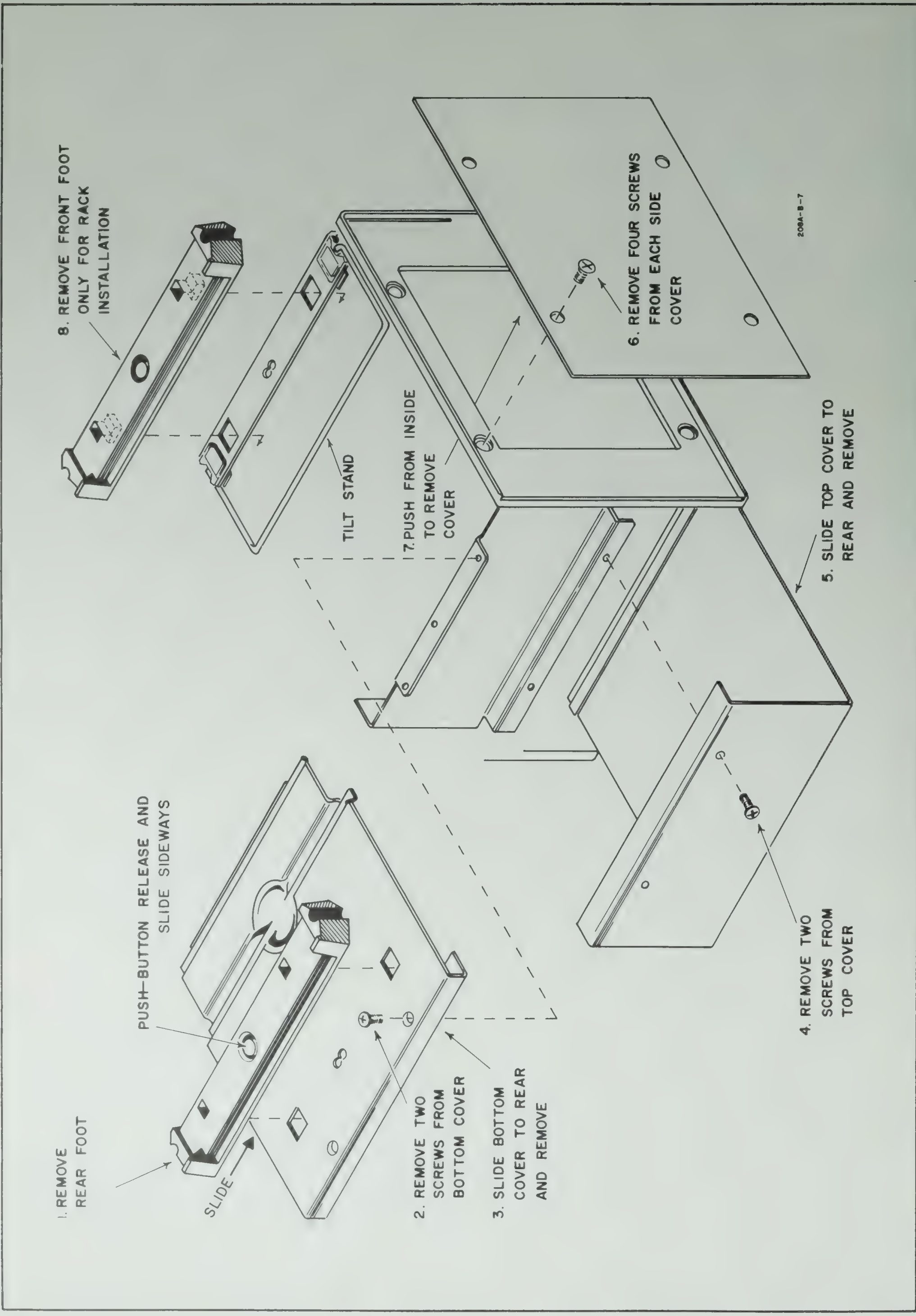


Figure 5-1. Cover Removal

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains maintenance and service information on the Model 208A/208A-DB Test Oscillator. A performance check is included in this section which may be used to verify instrument operation. This check can be made with the covers attached to the instrument and is a good test as part of preventative maintenance and incoming quality control inspection.

5-3. TEST INSTRUMENTS REQUIRED.

5-4. Table 5-1 lists the necessary test equipment required to test the Model 208A/208A-DB. The necessary specifications required to test this instrument are listed so other equipment with the equivalent specification may be used.

5-5. MECHANICAL ZERO ADJUSTMENT.

5-6. When the meter is properly zero-set the pointer rests over the zero calibration mark on the meter scale (on the Model 208A-DB the pointer rests over the (dot) calibration mark on the meter scale) when the instrument is 1) at normal operating temperature 2) in its normal operating position, and 3) turned off. Zero-set as follows to obtain best accuracy and mechanical stability.

a. Turn the instrument off and allow 20 seconds for all capacitors to discharge.

b. Rotate mechanical zero-adjustment screw clockwise until the meter pointer is to the left of zero and moving to the right toward zero.

Table 5-1. Required Test Equipment

Instrument Type	Required Characteristics	Use	Recommended Model
Oscilloscope	Passband: DC to 600 Kc Sensitivity: 0.1 volts/cm Input Impedance: 1 megohm	Waveform Measurement	hp Model 175A with plug-in Model 1753A
Distortion Analyzer	Measure distortion to -40 db at 1 Kc	Distortion Measurement	hp Model 330B/C/D
AC Voltmeter	Frequency Range: 5 cps to 600 Kc Voltage Range: 1 Mv to 3 v Accuracy: ±2% DB Scale	AC Voltage DB Measurements	hp Model 403B-DB
DC Voltmeter	Voltage Range: Positive and negative voltages from 100 Mv to 15 volts. Input Impedance: at least 10 megohms	DC Voltage Check	hp Model 412A
Frequency Counter	Counting Range: 5 cps to 600 Kc Accuracy: .03%	Frequency Measurements	hp Model 5232A
Standing Wave Indicator (1000 cps tuned AC Voltmeter)	Band width: 60 cps Frequency: 1 Kc Range: 60 db	Attenuation Check	hp Model 415D
Clip on DC Milliammeter	Current Range: 3 Ma to Accuracy: ±3% ±0.1 Ma	Power Supply Adjustment	hp Model 428A or B
Attenuator	Attenuation: 110 db in 1 db steps Accuracy: 110 db range less than ±0.25 db from DC to 560 Kc Impedance: 600 ohms	Attenuation Check	hp Model 350D
Resistor	600 ohms 5 watts ±1%	Maintenance Tests	
Variable Auto Transformer	Voltage Range: 102 - 128 vac Meter Accuracy: ±2% Power Capability: 5 watts	Power Supply Test	

Table 5-2. Troubleshooting Summary

Indication	Action	Indication	Action
No output signal	Check power supply voltages (+13 and -13 volts) Check Q3, Q4, CR2 and CR3 for correct DC voltages (refer to Figure 5-14) Check peak detector circuit (Q5, CR4, CR5 and CR6)		Check peak detector circuit (Q5, CR4, CR5 and CR6) for proper operation. Refer to waveforms and voltages in Figure 5-14. Be sure CR6 breaks down at 7 volts' peak
		If all ranges are affected	Check for incorrect voltages at Q3, Q4, Q2 and Q1, respectively.
No output on one or more ranges	Check RANGE switch contacts Check components connected to Wien bridge position when RANGE switch is inoperative position. For example, if inoperative position is X1, check C2A and C7A. Check components connected to peak detector circuit when RANGE switch is in inoperative position.	If all ranges are NOT affected	Check components connected to peak detector circuit in affected ranges.
		Low reading on BATT. test.	Recharge Batteries
		Battery will not hold charge	CR106 shorted or shorted cell in battery.
		Battery charge inoperative	Q101, CR101 thru CR104, CR105, C101 shorted Switch may be in 230 v position when using 115 v AC power
Output amplitude not correct and/or distorted	Check power supply voltages (+13 and -13 volts). Check components in upper and lower legs of Wien bridge for proper value ± percent of tolerance (refer to Table 6-1 for tolerances). For example, when RANGE switch is in X1 position, check R24, R4, C2A, R10A, R10B, R11 and C7A.	R45 will not adjust for full scale indication	CR7, 8 bad; Q6, Q7 bad
		Meter does not track properly Meter reads consistently above or below all meter divisions	Check CR7, 8 or Meter M1; R51 changed value
		Excessive charging rate R102 no effect	Check CR105, Q101

c. Continue to rotate adjustment screw clockwise; stop when pointer is on the zero line. If the pointer overshoots zero, repeat steps b and c.

d. When the pointer is exactly on zero, rotate the adjustment screw approximately 15 degrees counterclockwise. This is enough to free the adjustment screw from the meter suspension. If pointer moves during this step, repeat steps b through d.

5-7. TROUBLE SHOOTING.

5-8. To assist in troubleshooting, Table 5-2 is included in this section of the manual. Information contained in this table can be used for evaluating problems that may be encountered and easily recognized by the technician to localize areas of trouble encountered while testing the Model 208A/208A-DB.

5-9. INSTRUMENT COVER REMOVAL.

5-10. Figure 5-1 illustrates the removal of all covers. This should be necessary only when maintenance is required.

5-11. REPAIR.

5-12. SERVICING ETCHED CIRCUIT BOARDS.

5-13. The Model 208A/208A-DB uses single sided eyeletted etched circuit boards. When servicing this type of board, it recommended that the soldering iron tip be applied to the conductor side of the board at the component lead. For large components, such as potentiometers, rotate the soldering iron tip from lead to lead while applying pressure to the part to lift it from the board or use a soldering tip such as Ungar #855 3/4 in. Cup Tip. In addition to the above information, the following should be observed.

a. Before attempting a repair, determine the nature and location of the malfunction -- unnecessary replacements may complicate the repair procedure. Do not repair or replace any component unless it is proved necessary. (Be sure the trouble cannot be cleared by an adjustment.)

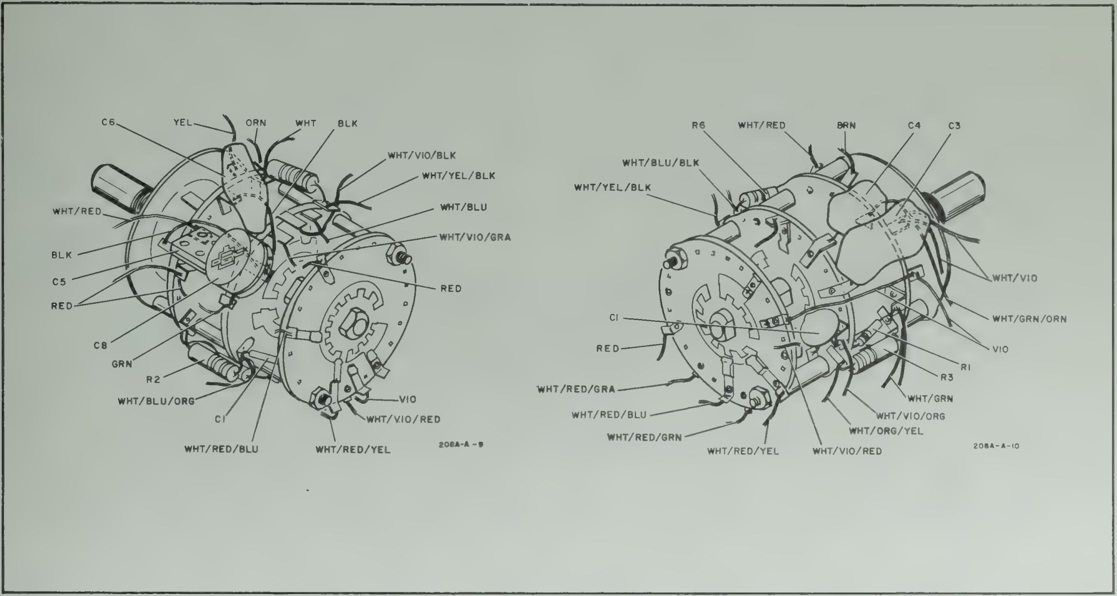


Figure 5-2. Range Switch Details

Figure 5-3. Cams and Cable Relationship

b. Turn off power to the instrument before performing any soldering.

c. Avoid using a high wattage soldering iron on the etched circuit boards. Excessive heat and pressure may lift a copper strip or warp the board, increasing susceptibility to mechanical damage. A lifted strip may be re-cemented with a quick drying acetate cement having good electrical insulation characteristics. A broken conductor strip may be joined by a strip of tinned copper wire.

d. To remove a damaged component, clip leads near component; then apply heat and remove component lead with a straight upward motion.

e. Use a toothpick or wooden splinter to clear holes before inserting new components.

f. To insure good connection between the eyelet and conductor of the printed board, always solder from the conductor side.

5-14. TRANSISTOR REPLACEMENT.

5-15. Transistors can be damaged by excessive heat. When replacing transistors on the Model 208A/208A-DB printed circuit boards, follow the instructions given in Paragraph 5-13.

5-16. RANGE SWITCH REPAIR.

5-17. Figure 5-2 gives parts location and cabling detail on Model 208A/208A-DB RANGE switch.

5-18. FREQUENCY POTENTIOMETER REPLACEMENT.

5-19. To replace the frequency potentiometer, R10A and R10B:

a. Free front panel from side casting, and remove top, bottom, and left side covers.

b. Remove RANGE switch knob and retaining nut.

c. Orient cams as shown in Figure 5-3A. Remove VERNIER knob and FREQUENCY dial.

d. Using a 3/8" open end wrench, turn cable terminal bolt on pot cam counterclockwise until cable slips off cam.

e. Loosen pot shaft locknut and panel bushing nut. Counterweight will come off at this time.

f. Unsolder the 4 wires from pot. Note wire color vs. pot terminal.

g. Slide pot cam along pot arm to allow access to pot mounting screws. Using an offset screwdriver, remove the three pot mounting screws.

h. Slide front panel out of right side casting. Gently move front panel away from the instrument far enough to allow removal of the pot. The pot cam will slide off as the pot is removed.

i. Install the new pot. Orient cams as shown in Figure 5-3. Reverse steps a through g. (The shorter cable length should pass over points A and B; the longer length should pass over points D, B and C.

j. Turn cable terminal clockwise approximately 1/2 turn to remove some slack in the cable.

k. Install counterweight and tighten panel bushing nut. Counterweight is keyed and should be positioned as shown in Figure 5-3AB.

m. Align pot cam to the same plane as dial cam.

n. Remove all slack in cable by turning cable terminal bolt clockwise. Do not overtighten cable.

p. With cams aligned, tighten pot shaft locknut.

q. Reassemble front panel and side casting. Be sure that the connecting link on VERNIER shaft becomes engaged in potentiometer R8.

r. Perform Frequency Calibration Adjustments. (See Paragraph 5-47.)

s. Replace top and bottom covers.

5-20. CAM CABLE REPLACEMENT.

5-21. If it is necessary to replace the cam cable. order it by ⓗ Stock No. 8160-0003 and description. Use Figure 5-3A as a guide, and proceed as follows:

a. Orient cams as shown in Figure 5-3A.

b. Using a 3/8-inch wrench, remove both cable terminal bolts.

c. Remove terminal bolts from cable.

d. On replacement cable, place a mark 6-7/8 inches from the end.

e. Slide replacement cable through one terminal bolt so that the cable is oriented to terminal bolt as shown in Figure 5-3A, lower left detail.

f. With mark on the cable in center of terminal bolt as shown, install terminal bolt on dial cam.

g. Slide cable ends approximately 1/4 inch through second terminal bolt so that cable is oriented to terminal bolt as shown in Figure 5-3A, upper left detail.

h. Orient the cams as shown in Figure 5-3B and use the figure as a guide. Slide the cable onto the cams, and install the second terminal bolt on the pot cam. (The shorter cable length should pass over points A and B; the longer length should pass over points D, B, and C.)

i. Tighten both terminal bolts to remove all slack in cable and allow the dial to cover its full range. Do not overtighten cable.

j. Perform Frequency Calibration Adjustments, Paragraph 5-49.

5-22. ATTENUATOR MAINTENANCE.

5-23. Maintenance of the output attenuator in the ⓗ Model 208A/208A-DB should be minimal unless an overload voltage or physical damage requires replacement of a part. To prevent signal leakage across terminals at high frequencies, keep the instrument free of dust. The attenuator shaft bushings under the front panel DB knobs should be lubricated annually with one drop of light machine oil. Figure 5-12 is a schematic diagram for the Model 208A-DB. The schematic diagram for the Model 208A is shown on the overall schematic diagram, Figure 5-14.

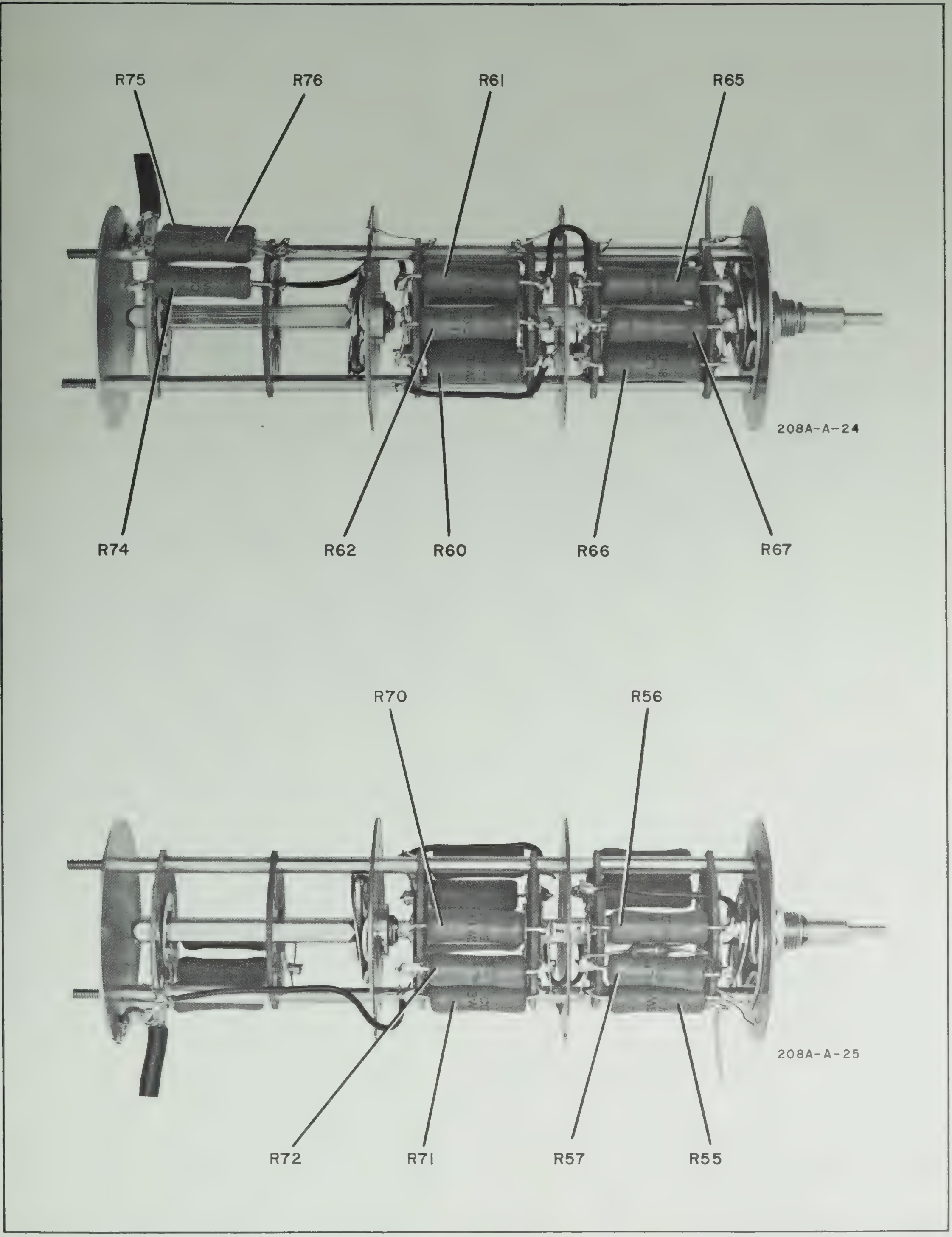


Figure 5-4. Model 208A Meter Scale Value/Multiplier

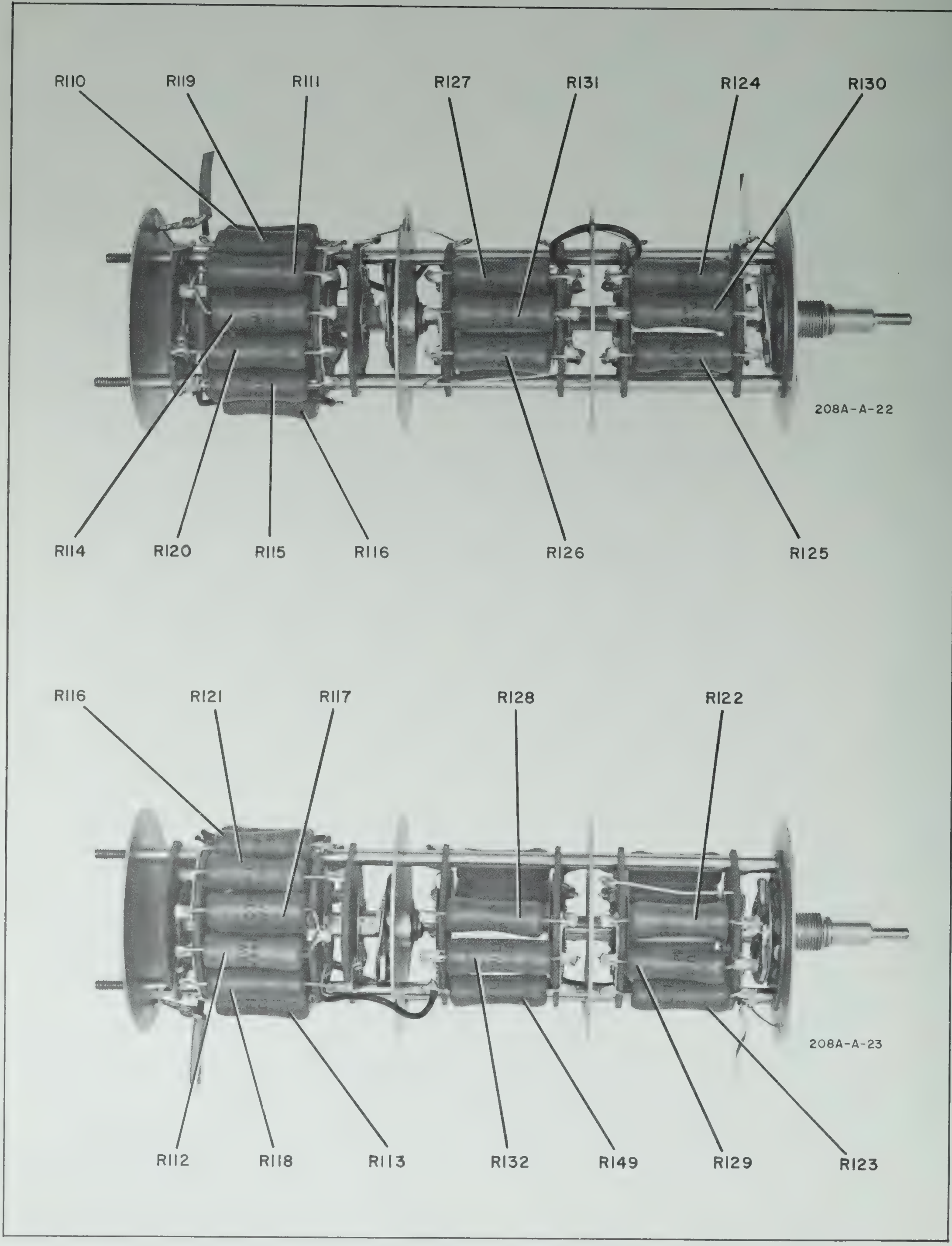


Figure 5-5. Model 208A-DB Attenuator

5-24. REMOVAL OF OUTPUT ATTENUATOR.

a. Remove all instrument covers (see Figure 5-1).

b. Loosen screws in both attenuator knobs and remove knobs.

c. Remove shield from output connector, disconnect coaxial output cable from connector, and disconnect wire from SET LEVEL control. Mark cables for proper reinstallation.

d. Remove flathead screws which fasten rear chassis to instrument side castings. Remove attenuator switch shaft nut holding attenuator assembly to the front panel.

e. Remove attenuator chassis from instrument frame.

f. Remove the slotted metal sleeve which clamps the shield around the attenuator assembly. With the shield removed, all the resistors in the OUTPUT attenuator are easily accessible for maintenance and repair. Refer to Figures 5-12 or 5-14 for the attenuator schematic.

g. Reassembly is essentially the reverse of the above procedure.

5-25. REPLACEMENT OF RESISTORS.

5-26. Figure 5-4 identifies the resistors on the Model 208A attenuator (Assembly A5) and Figure 5-5 on the Model 208A-DB attenuator (Assembly A6). Replacement resistors may be ordered from the parts information in Section VI. When a resistor is replaced, a padding resistor may be necessary to restore calibration accuracy.

5-27. ADJUSTMENTS.

5-28. The following is a complete test and adjustment procedure and should be performed only if it has definitely been determined that the Model 208A/Model 208A-DB is not functioning properly. If the instrument fails to make any one of the limits given in the following steps, carefully recheck your connections and procedure.

5-29. PERFORMANCE TESTS.

5-30. Before attempting to repair this instrument determine the nature and location of the malfunction; the fault may not be in the instrument under test but the associated circuit under test.

Note

Perform this test before disturbing any of the INTERNAL adjustments of the instrument.

5-31. This test may be used as an incoming inspection test to insure the instrument has not been damaged in shipment, for periodic maintenance or to check the operation of the instrument after repairs.

5-32. The following tests are performed with the AC power cord connected to 60 cycle line voltage.

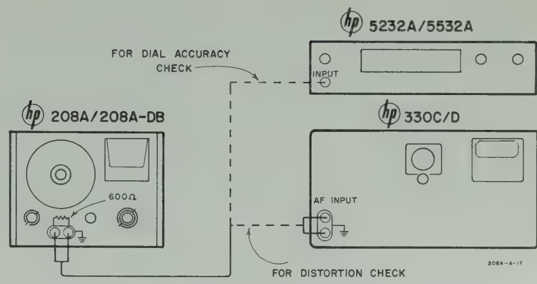


Figure 5-6. Test Setup for Dial Accuracy or Distortion Check

5-33. DIAL ACCURACY CHECK.

a. Connect frequency counter and 600 ohm load to oscillator output as shown in Figure 5-6.

b. Set Model 208A/208A-DB controls as follows:

RANGE X1
FREQ. 5
SET LEVEL . . . . . . MAXIMUM CLOCKWISE
VERNIER . . . . centered
METER SCALE VALUE (208A) 1. 0V
MULTIPLIER (208A) 2. 5
110 db Attenuator (208A-DB) 0
10 db Attenuator (208A-DB) 0

c. Set frequency counter controls as follows:

FUNCTION. . . . . . . .1 PERIOD AVERAGED
SENSITIVITY. 3
DISPLAY. . . . . . .maximum counterclockwise

d. Counter should read 200 ±6 ms.

e. Set FREQ. dial to 20, counter should read 50. 0 ±1. 5.

f. Set FREQ. dial to 50, counter should read 20. 0 ±0. 6.

g. Set RANGE to X10 and FREQ. dial to 5, counter should read the same as step f.

h. Repeat steps e and f with RANGE at X10. Counter should read 5. 00 ±0. 15 and 2. 00 ±0. 06 respectively.

i. Set frequency counter function switch to FREQ. (1 sec. gate).

j. Complete check by setting RANGE switch and FREQ. dial as shown in Table 5-3, columns one and two. The counter reading should be as shown in column three.

Table 5-3. Dial Accuracy

Range Switch	Freq. Dial	Counter-Reading
X100	5	500 cps ±15 cps
X100	20	2000 cps ±60 cps
X100	50	5000 cps ±150 cps
X1K	5	5 Kc ±150 cps
X1K	20	20 Kc ±600 cps
X1K	50	50 Kc ±1. 5 Kc
X10K	5	50 Kc ±1.5Kc
X10K	20	200 Kc ± 6 Kc
X10K	50	500 Kc ±15 Kc

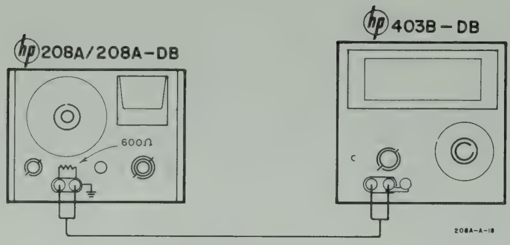


Figure 5-7. Test Setup for Frequency Response and Output Voltage Check

5-34. FREQUENCY RESPONSE AND OUTPUT VOLTAGE CHECK

a. Connect AC voltmeter and 600 ohm load to oscillator output as shown in Figure 5-7.

b. Set Model 208A/208A-DB RANGE to X1 and FREQ. dial to 25.

c. METER SCALE VALUE (208A)	1.0V
MULTIPLIER (208A)	X2.5
10 db Attenuator (208A-DB)	db
110 db Attenuator (208A-DB)	db

d. Adjust SET LEVEL control for 2.5 volt reading on voltmeter.

e. Sweep FREQ. dial by hand to read 50. As dial is swept, voltmeter reading should not vary more than ±0.075 volts.

f. Set Model 208A / 208A-DB RANGE to X10.

g. Set FREQ. dial to 5 and repeat step e.

h. Repeat steps d and e with RANGE switch set to X100, X1K and X10K.

5-35. DISTORTION CHECK

a. Connect distortion analyzer and 600 ohm load to oscillator output as shown in Figure 5-6.

b. Set Model 208A/208A-DB controls as follows:

RANGE	X100
FREQ.	10 (1Kc)
SET LEVEL	MAXIMUM CLOCKWISE

c. Set distortion analyzer controls as follows:

FREQUENCY RANGE	X100
INPUT	AF
FUNCTION	SET LEVEL
METER RANGE	100%

d. On distortion analyzer:

(1) Adjust INPUT SENSITIVITY for full scale reading (1.0).

(2) Set FUNCTION to DISTORTION.

(3) Adjust FINE and COARSE frequency controls and BALANCE control for dip or null (on distortion analyzer meter) at fundamental frequency (1 Kc); switch METER RANGE as necessary to obtain upscale meter reading.

(4) Readjust controls until maximum meter dip or null is obtained.

e. Meter reading should be less than 1.0 on the 1% range.

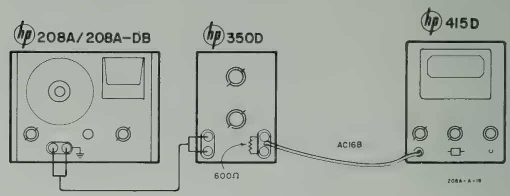


Figure 5-8. Attenuation Check

5-36. ATTENUATION CHECK (Model 208A).

a. Connect equipment as shown in Figure 5-8.

b. Set Model 208A controls as follows:

RANGE	X100
FREQ.	10
SET LEVEL	MAXIMUM CLOCKWISE
METER SCALE VALUE	1.0 volt
MULTIPLIER	2.5

c. Position the Model 350D Attenuator to 100 db.

d. Set hp Model 415D Standing Wave Indicator (1000 cycle tuned Voltmeter) as follows:

RANGE	50DB
INPUT SELECTOR	XTAL-200K
POWER	AC

e. Adjust the FREQ. control on the Model 208A for peak indication on the Model 415D.

f. Adjust the SET LEVEL control on the Model 208A for a 0.8 reference indication on the Model 208A.

g. Adjust GAIN control on the Model 415D for a -1 db indication on the Model 415D meter scale.

h. Position the METER SCALE VALUE switch on the Model 208A to the 0.1, .01, 1 Mv, 0.1 Mv, and .01 Mv positions and simultaneously position the 350D attenuator to the 80, 60, 40, 20 and 0 db positions.

i. The Model 415D should indicate 0 db ±.15 db on all steps.

Note

The Model 415D is calibrated for square law detectors. The specification called out is exactly half of the specifications called out in Tables 1-1 and 1-2.

j. Disconnect the Model 208A from test setup shown in Figure 5-8. Connect a 600 ohm resistor and an AC Voltmeter to the OUTPUT terminals of the Model 208A.

k. Position the METER SCALE VALUE switch to the .10 volt position and the MULTIPLIER switch to the 2.5 position.

m. Position the RANGE switch on the AC voltmeter to the 3 volt range and adjust the SET LEVEL control on the Model 208A to read exactly 2.50 volts, read on the AC Voltmeter. Observe the indication on the Model 208A monitor meter.

n. Position the MULTIPLIER switch on the Model 208A to the 1.0 position. Reset the SET LEVEL control to indicate reading observed in step m. The AC Voltmeter should indicate 1 volt ±.02 volts.

5-37. ATTENUATION CHECK (Model 208A-DB).

a. Connect equipment as shown in Figure 5-8.

b. Set Model 208A-DB front panel controls as follows:

RANGE	X100
FREQ.	10
SET LEVEL	MAXIMUM CLOCKWISE
ATTENUATOR 10 db section	0 db
ATTENUATOR 100 db section	0 db

c. Set the ⓗⓟ Model 415D Standing Wave Indicator (1000 cycle tuned voltmeter) as follows:

RANGE	0 db
INPUT SELECTOR	XTAL-200K
POWER	AC

d. Position the 10 db and 100 db switches on the Model 350D to 0 db.

e. Adjust the FREQ. control on the Model 208A-DB for peak indication on the ⓗⓟ Model 415D.

f. Adjust the SET LEVEL control on the Model 208A-DB for a +10 db reference indication on the Model 208A-DB.

g. Set the GAIN control on the Model 415D for a 0 db indication on the Model 415D meter scale.

h. Position the ATTENUATOR (10 db section) on the Model 208A-DB in 1 db steps, noticing tracking error on ⓗⓟ Model 415D, and maintaining a +10 db reference on the Model 208A-DB.

Note

The Model 415D is calibrated for square law detectors. The specifications called out are exactly half of the specifications called out in Table 1-1 and Table 1-2.

i. The error as indicated on the ⓗⓟ Model 415D should not exceed .0625 db at any step.

j. Position the 100 db attenuator on the ⓗⓟ Model 350D to 100 db and the 10 db attenuator on the Model 208A-DB to 0 db.

k. Position the RANGE switch on the Model 415D to 50 db.

m. Adjust the SET LEVEL control on the Model 208A-DB for a +10 db indication on the Model 208A-DB.

n. Set the GAIN control on the Model 415D for a -1 db indication on the 415D meter scale.

p. Position the ATTENUATOR (100 db section) on the Model 208A-DB on 10 db steps while simultaneously positioning the 100 db attenuator on the Model 350D in 10 db steps, maintaining a +10 dbm level on the Model 208A-DB monitor meter.

q. The Model 415D should indicate -1 db ±.125 db at all ranges.

5-38. OUTPUT MONITOR CHECK. (Model 208A)

To check the OUTPUT MONITOR proceed as follows:

a. Set the Model 208A as follows:

RANGE	X100
FREQ.	10
METER SCALE VALUE	1V
MULTIPLIER	1.0

b. Connect a 600 ohm resistor and an AC voltmeter (ⓗⓟ Model 403B-DB) across the OUTPUT terminals of the Model 208A.

c. Set the AC voltmeter (ⓗⓟ Model 403B-DB) as follows:

FUNCTION	ON
RANGE	1

d. Adjust the SET LEVEL control to indicate 1.0 on the monitor meter on the Model 208A.

e. The AC Voltmeter should indicate .98 to 1.02 volts.

f. Adjust the SET LEVEL control on the Model 208A for a 0.8, 0.6, 0.4 and 0.2 indication consecutively on the AC Voltmeter while noting indication on the monitor meter on the Model 208A. The monitor meter should read 0.8, 0.6, 0.4 and 0.2 ±1 division.

5-39. OUTPUT MONITOR CHECK (Model 208A-DB).

To check the OUTPUT MONITOR proceed as follows:

a. Set the Model 208A as follows:

RANGE	X100
FREQ.	10
ATTENUATOR 10 db	0 db
ATTENUATOR 100 db	0 db

b. Connect a 600 ohm resistor and an AC volt meter (ⓗⓟ Model 403B-DB) across the OUTPUT terminals of the Model 208A-DB.

c. Set the AC voltmeter as follows:

FUNCTION	ON
RANGE	+10 db

d. Adjust the SET LEVEL control to indicate +10 dbm on the Model 208A-DB monitor meter.

e. The AC voltmeter should indicate 0 dbm ±.2 dbm.

f. Adjust the SET LEVEL control on the Model 208A-DB for a +8, +6, +4, +2, 0 and -5 dbm indication consecutively on the Model 208A monitor meter, while noting indication on the AC voltmeter. The AC voltmeter should read -2 dbm ±.25 dbm, -4 dbm ±.3 dbm, -6 dbm ±.4 dbm, -8 dbm ±.5 dbm, -10 dbm ±.6 dbm.

g. Position the RANGE switch on the AC voltmeter to 0 db position. The AC voltmeter should read -5 dbm ±1.1 dbm.

Table 5-4. 208A Battery Test Values

Indication on DC Voltmeter (Battery Voltage)	Indication on Output Monitor (Adjust R78)
24.0	0.800
24.5	0.817
25.0	0.833
25.5	0.850
26.0	0.867
26.5	0.883
27.0	0.900
27.5	0.917
28.0	0.933
28.5	0.950
29.0	0.967
29.5	0.983
30.0	1.000
30.5	1.017
31.0	1.033

Table 5-5. 208A-DB Battery Test Values

Indication on DC Voltmeter (Battery Voltage)	Indication on Output Monitor (Adjust R78)
24.0	+9.00 dbm - Start of Batt. Test
24.5	+9.20
25.0	+9.50
25.5	+9.60
26.0	+9.75
26.5	+9.90
27.0	+10.10
27.5	+10.20
28.0	+10.40
28.5	+10.60
29.0	+10.70
29.5	+10.80
30.0	+11.00
30.5	+11.10
31.0	+11.30

5-40. CALIBRATION PROCEDURE.

5-41. The following is a complete test and adjustment procedure and should be made only if it has been definitely determined that the ⓗⓟ Model 208A/208A-DB is out of adjustment as determined by Paragraph 5-29, Performance Test. If your instrument fails to make any one of the limits given in the following steps, carefully recheck your connections and procedure. If the Test Oscillator still fails the step refer to Table 5-2, Troubleshooting, for possible cause and corrective action.

5-42. Perform tests associated with the particular sections of the instrument shown to be faulty by the performance test. Indiscriminate adjustment of the internal controls to "refine" the settings may actually cause difficulty.

5-43. POWER SUPPLY.

a. Remove top cover from Model 208A/208A-DB cabinet. Refer to Figure 5-1.

b. Measure battery voltage, using an ⓗⓟ Model 412A DC Voltmeter; connect the common lead to the violet wire and the volts lead to the red wire on the batteries. Refer to Figure 5-9 and 5-10.

c. Hold FUNCTION switch on Model 208A/208A-DB to BATT. TEST position.

d. Note indication on ⓗⓟ Model 412A DC Voltmeter. Refer to Table 5-4 (Model 208A) or 5-5 (208A-DB) and adjust R78 until OUTPUT monitor on instrument under test reads the value called out in the table adjacent to the DC voltage noted on the ⓗⓟ 412A. Interpolate for values of DC voltage falling between those on the table.

CAUTION

DC Voltmeter must be isolated from Model 208A/208A-DB chassis ground.

Note

If voltage reading on ⓗⓟ 412A does not indicate 24 volts or above, recharge batteries in the Model 208A/208A-DB.

e. Insert power cord on the ⓗⓟ Model 208A/208A-DB into a variable autotransformer and adjust the autotransformer to 115 volts. Turn the RANGE switch on the Model 208A/208A-DB to OFF.

f. Connect the Model 428A or B Clip-on DC Ammeter Probe around the black wire on the batteries. Refer to Figures 5-9 and 5-13.

g. Adjust R102 for 5.5 Ma indication on Model 428A/B.

Note

If Model 208A/208A-DB Test Oscillator is scheduled for field usage, adjust R102 to 11.0 Ma. Refer to Paragraph 4-41.

h. Vary input line voltage with a variable autotransformer from 102 to 128 volts and verify indication on Model 428A or B indicates 5.5 Ma ±.5 Ma.

i. Connect an ⓗⓟ Model 403B/403B-DB AC Voltmeter across the red and violet wires on the batteries. The ripple shall not exceed 1 millivolt.

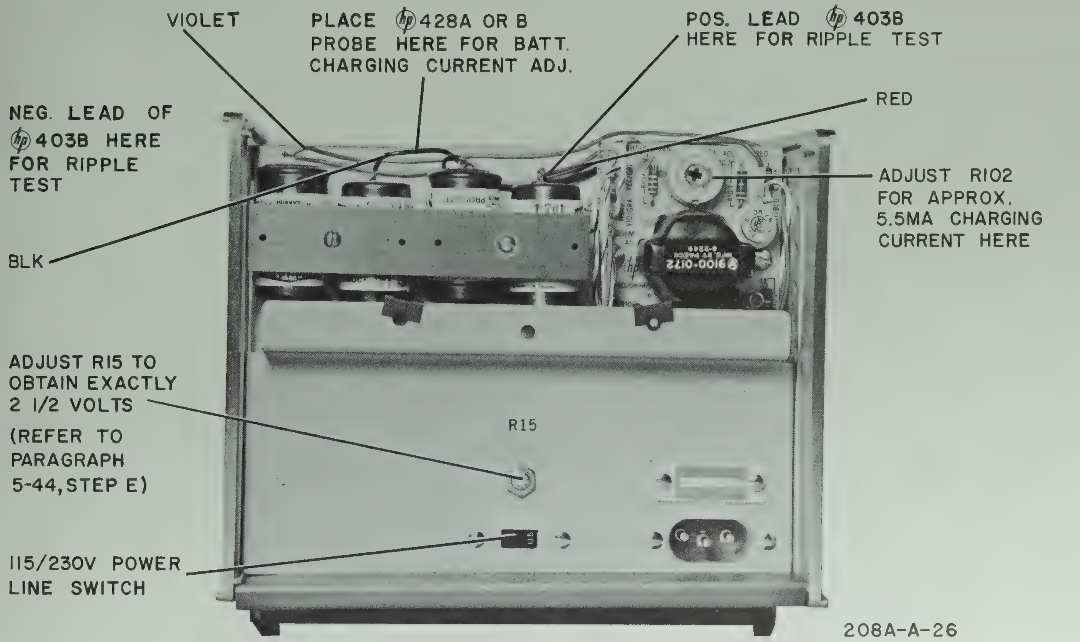


Figure 5-9. Rear View (Illustrating Charging Board)

5-44. METER CALIBRATION (Model 208A).

a. Connect a 600 ohm resistor and an AC voltmeter (hp Model 403B-DB) across the OUTPUT terminals of the Model 208A.

b. Set the Model 208A as follows:

RANGE	X10
FREQ.	40
METER SCALE VALUE	1V
MULTIPLIER	2.5

c. Set the AC voltmeter (hp Model 403B-DB) as follows:

FUNCTION	ON
RANGE	3

d. Adjust the SET LEVEL control on the Model 208A until the AC voltmeter reads exactly 2.5 volts rms.

Note

If AC Voltmeter does not indicate 2.50 volts adjust R15 (rear panel).

e. Adjust R45 (400 cps CAL) until the monitor meter on the Model 208A reads exactly full scale (1.0). Refer to Figure 5-10.

f. Set the Model 208A as follows:

RANGE	X10K
FREQ.	56

g. Adjust the SET LEVEL control on the Model 208A until the AC voltmeter indicates exactly 2.5 volts.

h. Adjust C34 (560 Kc CAL) control until the monitor meter on the Model 208A reads exactly full scale (1.0). Refer to Figure 5-10.

5-45. METER CALIBRATION (Model 208A-DB).

a. Connect a 600 ohm resistor and an AC voltmeter (hp Model 403B-DB) across the OUTPUT terminals of the Model 208A.

b. Set the Model 208A-DB as follows:

RANGE	X10
FREQ.	40
ATTENUATOR (10 db section)	0 db
ATTENUATOR (100 db section)	0 db

c. Set the AC voltmeter (hp Model 403B-DB) as follows:

FUNCTION	ON
RANGE	+10 DBM

d. Adjust the SET LEVEL control on the Model 208A until the AC voltmeter reads exactly +10 dbm.

Note

If AC voltmeter does not indicate +10 dbm adjust R15 (rear panel).

e. Adjust R45 (400 cps CAL) until the monitor meter on the Model 208A-DB reads exactly +10 dbm. Refer to Figure 5-10.

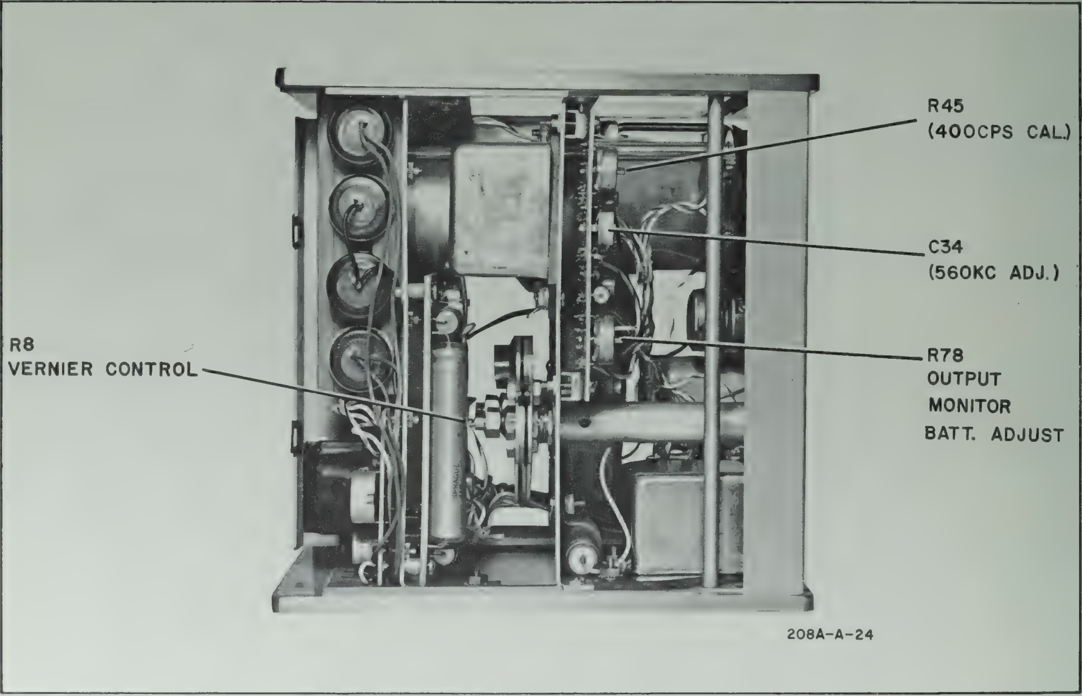


Figure 5-10. Top View

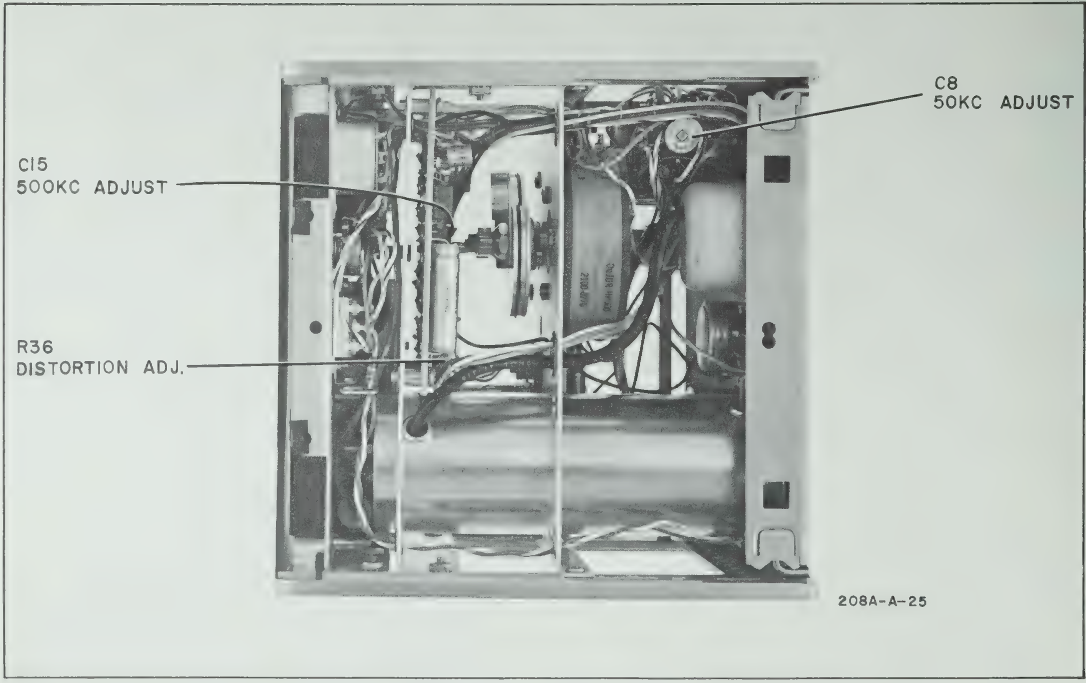


Figure 5-11. Bottom View

f. Set the Model 208A-DB as follows:

RANGE	X10K
FREQ.	56

g. Adjust the SET LEVEL control on the Model 208A-DB until the AC voltmeter indicates exactly 0 dbm.

h. Adjust C34 (560 Kc CAL) control until the monitor meter on the Model 208A-DB indicates +10 db. Refer to Figure 5-10.

5-46. DISTORTION ADJUSTMENT.

a. Connect a 600 ohm load across the oscillator output terminals.

b. Using an AC voltmeter, measure voltage between circuit ground and arm of potentiometer R36. Voltage should be between 90 and 140 Mv rms at 1 Kc. If voltage is high, increase resistance of R34; if low, decrease resistance.

c. Set Model 208A/208A-DB controls as follows:

RANGE	X100
FREQ.	10 (1 Kc)
VERNIER	centered
SET LEVEL	MAX.
METER SCALE VALUE (208A)	1V
MULTIPLIER (208A)	2.5
10 DB ATTENUATOR (208A-DB)	0 db
100 DB ATTENUATOR (208A-DB)	0 db

d. Connect distortion analyzer to 600 ohm load on oscillator output terminals.

e. Measure distortion, and adjust R36 (refer to Figure 5-11) for minimum reading. Reading should be less than 1%.

5-49. FREQUENCY CALIBRATION ADJUSTMENTS.

5-50. Frequency calibration adjustment should be performed, only if necessary, after repairs are made to frequency sensitive components.

a. Connect frequency counter and 600 ohm load to oscillator output as shown in Figure 5-6.

b. Set Model 208A / 208A - DB RANGE to X100, VERNIER to center of its range, and SET LEVEL to maximum clockwise position.

c. Set FREQ. to 50 (5 Kc).

d. Lock FREQ. dial shaft with a number 8-32 socket setscrew (dial shaft locking screw) which inserts into threaded hole on top of dial shaft housing.

CAUTION

Do not overtighten

e. Loosen potentiometer (pot) shaft locknut, Figure 5-3A, and adjust pot by turning pot arm to obtain a 5 Kc output.

f. Tighten pot shaft locknut, and loosen dial shaft locking screw.

g. Set FREQ. to 5 (500 cps) and tighten dial shaft locking screw.

h. Loosen dial shaft locknut, Figure 5-3A, and adjust dial cam by turning cam to obtain a 500 cps output.

i. Tighten dial shaft locknut and loosen dial shaft locking screw.

j. Repeat steps c through i until frequencies are within approximately ±1%.

k. Set RANGE to X10K, FREQ. to 5 (50 Kc), and adjust C8 (Figure 5-2) to obtain a 50 Kc output.

m. Set FREQ. to 50 (500 Kc) and adjust C15 (Figure 5-11) to obtain a 500 Kc output.

n. All frequencies across the band should be within ±3%.

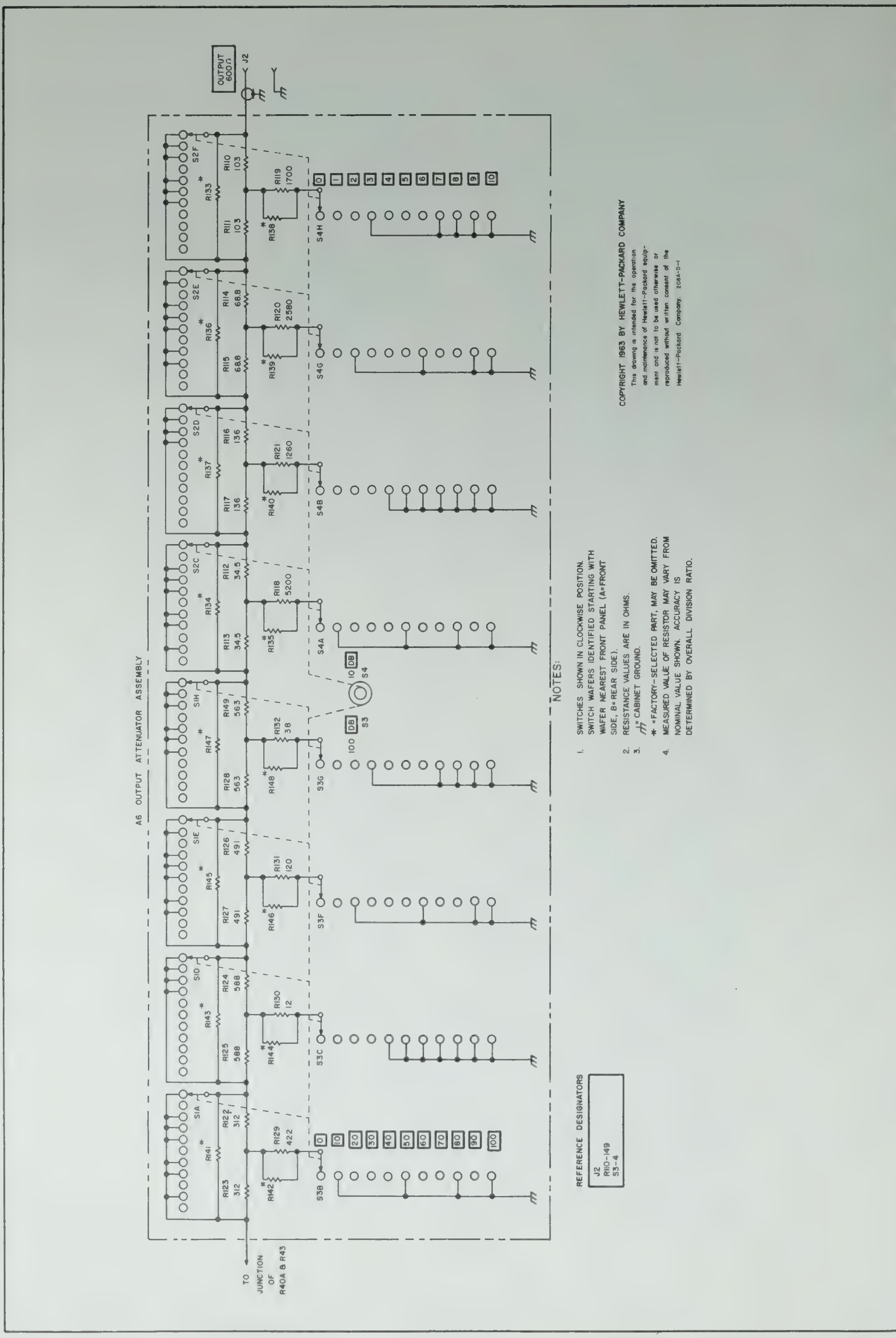


Figure 5-12. Model 208A-DB Output Attenuator Schematic

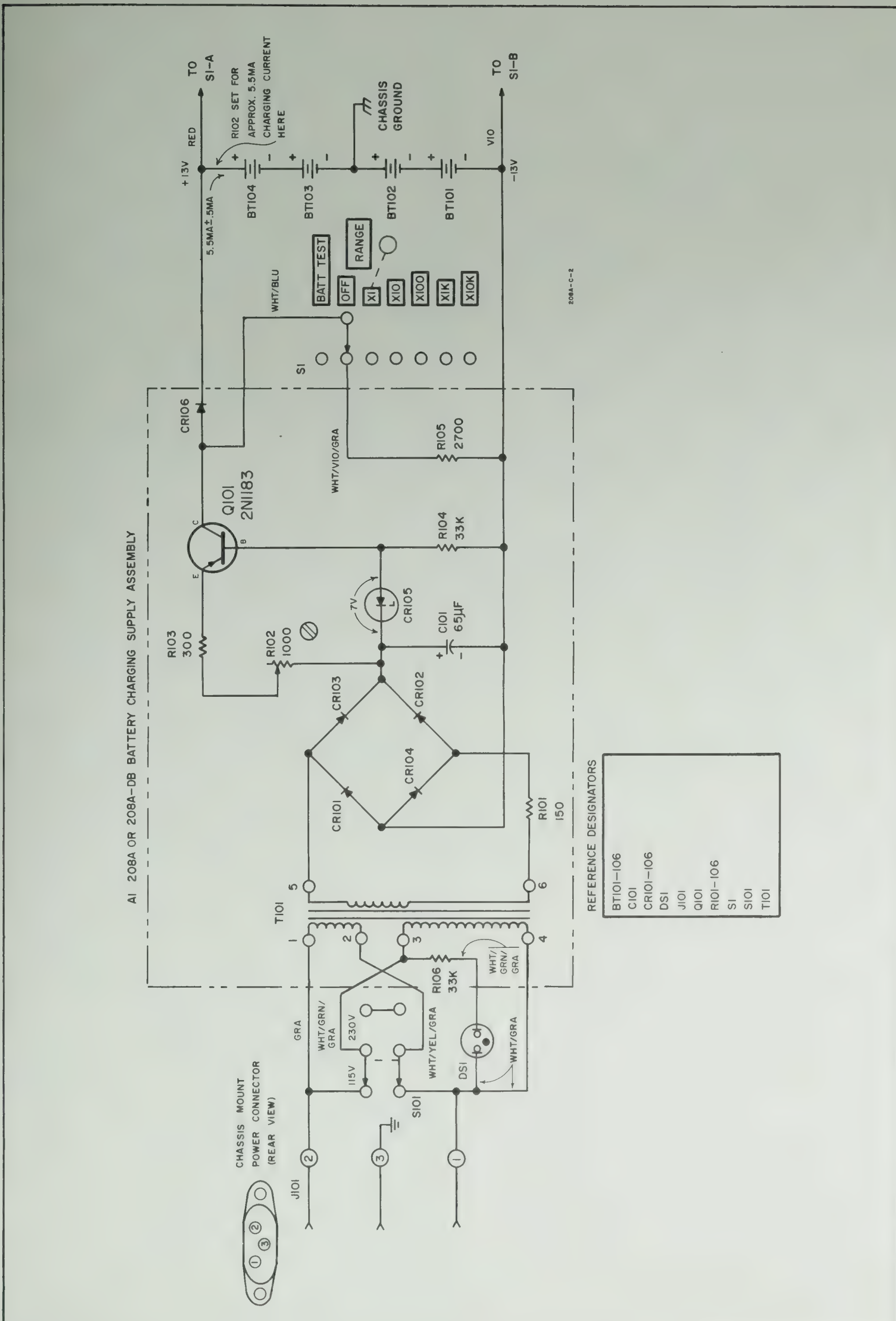
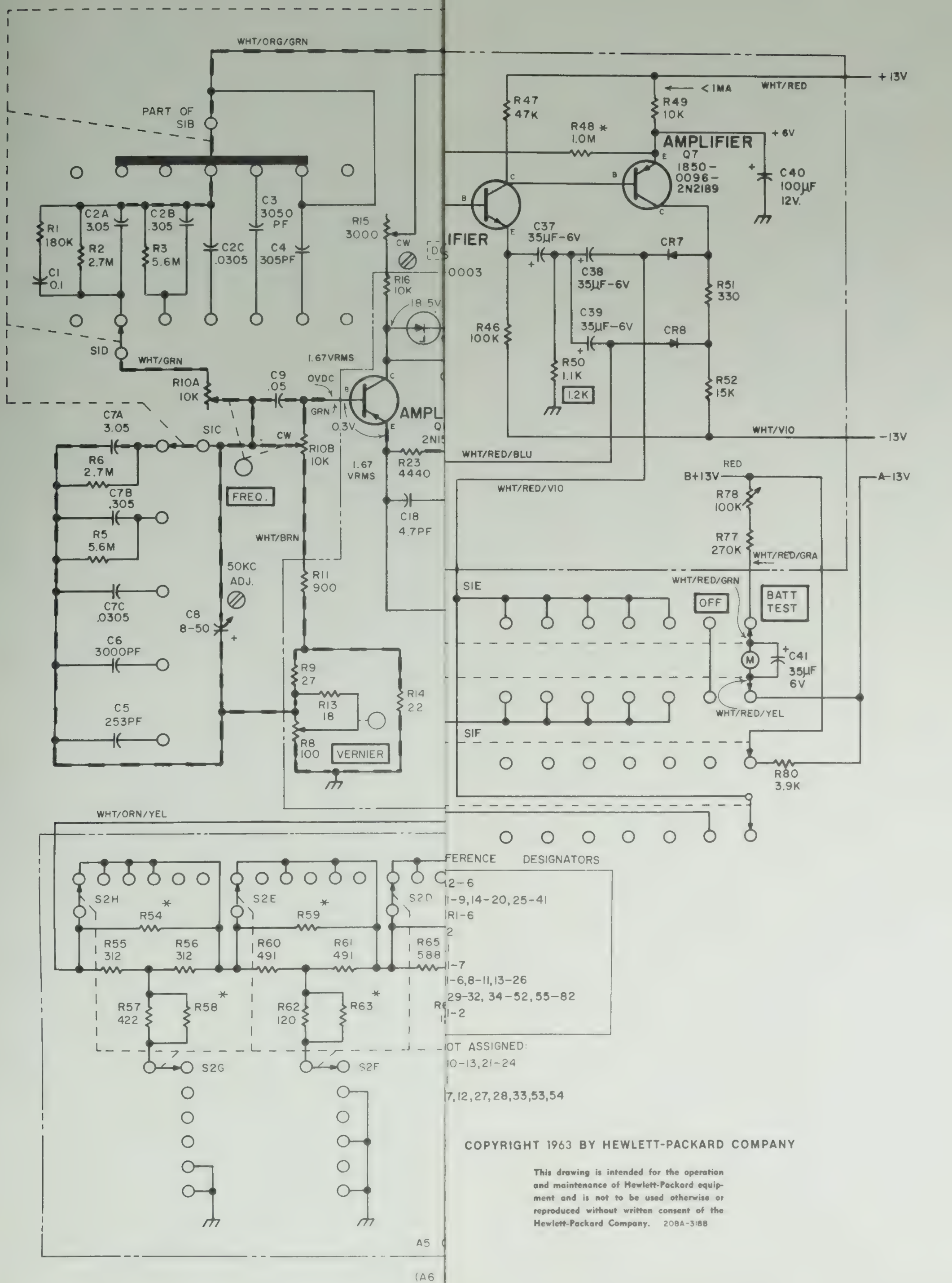
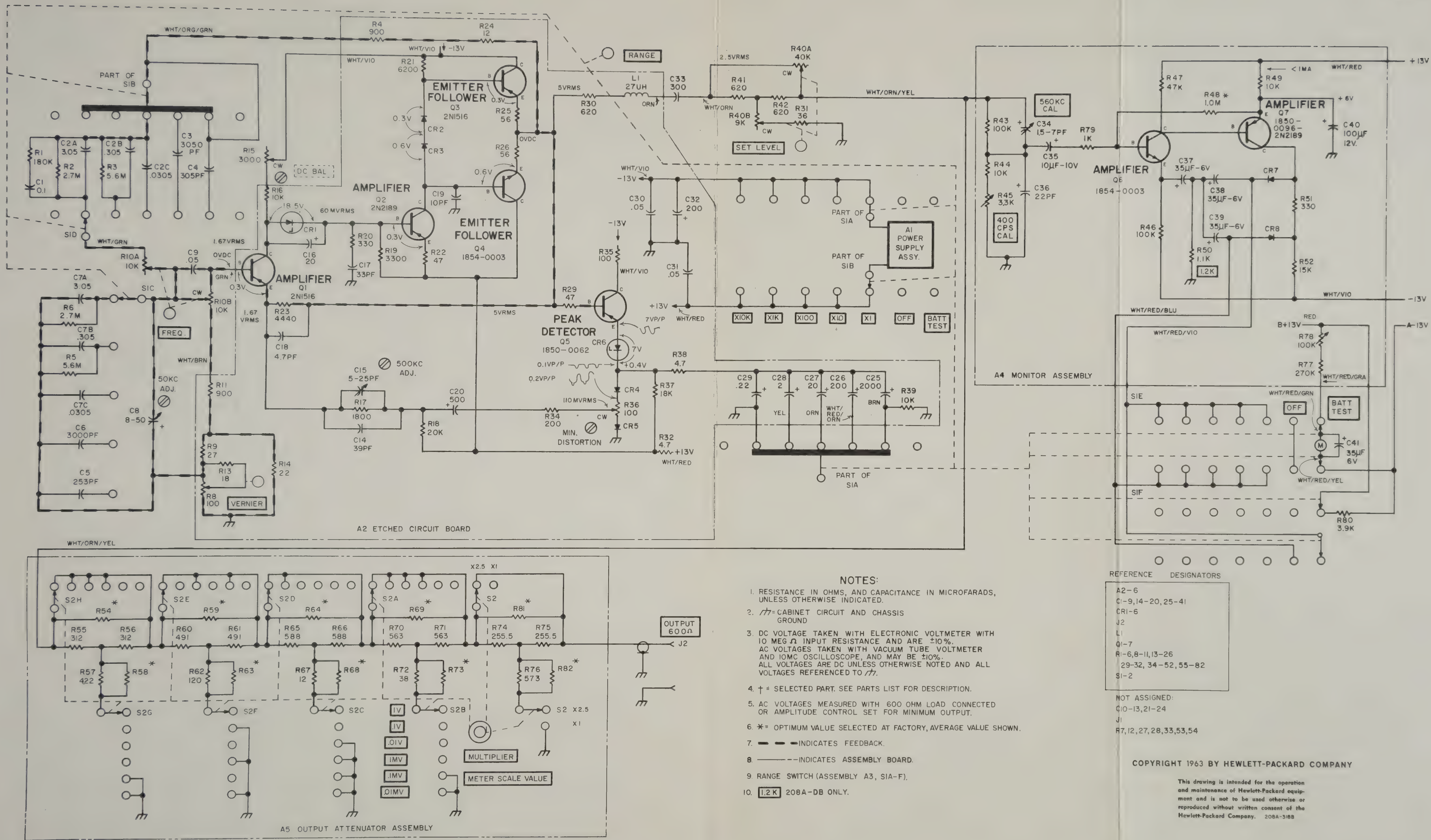


Figure 5-13. Model 208A/208A-DB Power Supply


WHT/ORG/GRN
PART OF SIB
R1 180K
C1 0.1
C2A 3.05
R2 2.7M
C2B .305
R3 5.6M
C2C .0305
C3 3050 PF
C4 305PF
SID
WHT/GRN
R10A 10K
C9 .05
1.67VRMS
OVDC
GRN
0.3V
R15 3000
CW
R16 10K
18.5V
C7A 3.05
SIC
CW
R6 2.7M
C7B .305
R5 5.6M
C7C .0305
C6 3000PF
C5 253PF
R10B 10K
FREQ.
1.67 VRMS
R23 4440
C18 4.7PF
WHT/BRN
50KC ADJ.
C8 8-50
R11 900
R9 27
R13 18
R14 22
R8 100
VERNIER
WHT/ORG/GRN
+13V
R47 47K
R49 10K
< IMA
WHT/RED
R48 * 1.0M
AMPLIFIER
Q7 1850-0096-2N2189
+6V
C40 100μF 12V.
C37 35μF-6V
C38 35μF-6V
CR7
R51 330
R46 100K
C39 35μF-6V
CR8
R50 1.1K
1.2K
R52 15K
WHT/VIO
-13V
WHT/RED/BLU
WHT/RED/VIO
RED
B+13V
R78 100K
R77 270K
WHT/RED/GRA
A-13V
SIE
WHT/RED/GRN
OFF
BATT TEST
C41 35μF 6V
WHT/RED/YEL
SIF
R80 3.9K
WHT/ORN/YEL
S2H
R54 *
R55 312
R56 312
R57 422
R58 *
S2G
S2E
R59 *
R60 491
R61 491
R62 120
R63 *
S2F
S2D
R65 588
DESIGNATORS
2-6
1-9,14-20,25-41
R1-6
1-7
1-6,8-11,13-26
29-32, 34-52, 55-82
1-2
NOT ASSIGNED:
10-13,21-24
7,12,27,28,33,53,54
A5
(A6



(A6 OUTPUT ATTENUATOR ASSEMBLY 208A-DB REFER TO FIG. 5-12.)

NOTES:

1. RESISTANCE IN OHMS, AND CAPACITANCE IN MICROFARADS, UNLESS OTHERWISE INDICATED.
2. ⏚ = CABINET CIRCUIT AND CHASSIS GROUND
3. DC VOLTAGE TAKEN WITH ELECTRONIC VOLTMETER WITH 10 MEG Ω INPUT RESISTANCE AND ARE ±10%. AC VOLTAGES TAKEN WITH VACUUM TUBE VOLTMETER AND 10MC OSCILLOSCOPE, AND MAY BE ±10%. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED AND ALL VOLTAGES REFERENCED TO ⏚.
4. † = SELECTED PART. SEE PARTS LIST FOR DESCRIPTION.
5. AC VOLTAGES MEASURED WITH 600 OHM LOAD CONNECTED OR AMPLITUDE CONTROL SET FOR MINIMUM OUTPUT.
6. * = OPTIMUM VALUE SELECTED AT FACTORY, AVERAGE VALUE SHOWN.
7. — — — INDICATES FEEDBACK.
8. ———— INDICATES ASSEMBLY BOARD.
9. RANGE SWITCH (ASSEMBLY A3, S1A-F).
10. [1.2K] 208A-DB ONLY.

REFERENCE DESIGNATORS

A2-6
C1-9, 14-20, 25-41
CR1-6
J2
L1
Q1-7
R1-6, 8-11, 13-26, 29-32, 34-52, 55-82
S1-2

NOT ASSIGNED:
C10-13, 21-24
J1
R7, 12, 27, 28, 33, 53, 54

Figure 5-14. Model 208A/208A-DB Schematic Diagram

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗⓟ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ⓗⓟ stock numbers and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quantity used in the instrument (TQ column).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts not indexed in Table 6-1 are listed at the end of Table 6-2.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry either to your Hewlett-Packard field office or to:

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S. A.
54-54bis Route Des Acacias
Geneva, Switzerland

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator

d. Description

6-7. To order a part not listed in Table 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	XF	= fuseholder
DL	= delay line	L	= inductor	S	= switch	XDS	= lampholder
DS	= device signaling (lamp)	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

a	= amperes	elect	= electrolytic	mtg	= mounting	rot	= rotary
bp	= bandpass	encap	= encapsulated	my	= mylar	rms	= root-mean-square
bwo	= backward wave oscillator	f	= farads	NC	= normally closed	rmo	= rack mount only
c	= carbon	fxd	= fixed	Ne	= neon	s-b	= slow-blow
cer	= ceramic	Ge	= germanium	NO	= normally open	Se	= selenium
cmo	= cabinet mount only	grd	= ground (ed)	NPO	= negative positive zero (zero temperature coefficient)	sect	= section(s)
coef	= coefficient	h	= henries	nsr	= not separately replaceable	Si	= silicon
com	= common	Hg	= mercury	obd	= order by description	sil	= silver
comp	= composition	impg	= impregnated	p	= peak	sl	= slide
conn	= connection	incd	= incandescent	pc	= printed circuit board	td	= time delay
crt	= cathode-ray tube	ins	= insulation (ed)	pf	= picofarads = 10^{-12} farads	TiO_2	= titanium dioxide
dep	= deposited	K	= kilo = 1000	pp	= peak to peak	tog	= toggle
EIA	= Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗⓟ stock numbers.	lin	= linear taper	piv	= peak inverse voltage	tol	= tolerance
		log	= logarithmic taper	pos	= position (s)	trim	= trimmer
		m	= milli = 10^{-3}	poly	= polystyrene	twt	= traveling wave tube
		M	= megohms	pot	= potentiometer	var	= variable
		ma	= milliamperes	rect	= rectifier	w/	= with
		μ	= micro = 10^{-6}			W	= watts
		minat	= miniature			ww	= wirewound
		mfgl	= metal film on glass			w/o	= without
		mfr	= manufacturer			*	= optimum value selected at factory, average value shown (part may be omitted)

Table 6-1. Reference Designation Index

Circuit Reference	Ⓗ Stock No.	Description	Note
A1	00208-66502	Ass'y power supply circuit board includes: C101 CR101 thru CR106 R101 thru R106 Q101 T101	
A2	00208-66503	Ass'y circuit board includes: CR1 thru CR6 R18 thru R21 L1 R22 Q1 thru Q5 R23 thru R26 R8, 9 R29, 30 R13, 14 R32 R16 thru R21 R34 thru R36 R38	
A3	00208-61901	Range switch includes: C1, 3, 4, 5, 6, 8 R1 R2, 3 R5, 6 S1	
A4	00208-66501	Ass'y meter circuit board includes: C34 thru C40 CR7, 8 R43 thru R52 R77 thru R79 Q6, 7	
A5	00208-63401	Ass'y output attenuator (208A) includes: R55 thru R57 R60 thru R62 R65 thru R67 R70 thru R72 R74 thru R76 S2	
A6	00208-63402	Ass'y output attenuator includes: R110 thru R149 S3, 4	
C1	0150-0084	C: fxd, .1μf +80% -20%, 50 vdcw	
C2A, B, C	0170-0076	C: fxd, 3 sections, 3.05μf, 0.305μf, 0.0305μf ±1% each	
C3	0140-0174	C: fxd, 3050 pf ±1%, 100 vdcw	
C4	0140-0173	C: fxd, 305pf ±1%, 100 vdcw	
C5	0140-0108	C: fxd, 253pf ±2%	
C6	0140-0172	C: fxd, 3000pf ±1%, 100 vdcw	
C7A, B, C		Same as C2A, B, C	
C8	0130-0017	C: fxd, var, 8-50pf, 500 vdcw	
C9	0150-0096	C: fxd, .05μf, 100 vdcw	
C10 thru C13		Not assigned	
C14	0140-0021	C: fxd, 39pf ±10%, 500 vdcw	
C15	0130-0016	C: var, cer, 5-25μf, 500 vdcw	
C16	0180-0045	C: fxd, -20μf, 25 vdcw	
C17	0140-0100	C: fxd, 33pf ±5%	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗ Stock No.	Description	Note
C18	0150-0042	C: fxd, 4.7pf ±5%, 500 vdcw	
C19	0150-0055	C: fxd, 10pf ±5%, 500 vdcw	
C20	0180-0063	C: fxd, elect, 500µf -10% +100%, 3 vdcw	
C21 thru C24		Not assigned	
C25	0180-0112	C: fxd, 2000µf, 1 vdcw	
C26	0180-0104	C: fxd, alum elect, 200µf, 15 vdcw	
C27		Same as C16	
C28	0180-0155	C: fxd, 2µf ±20%, 25 vdcw	
C29	0170-0038	C: fxd, .22µf ±10%, 200 vdcw	
C30	0150-0096	C: fxd, .05µf, 100 vdcw	
C31		Same as C30	
C32		Same as C26	
C33	0180-0140	C: fxd, alum elect, 300µf, 10 v	
C34	0130-0011	C: var, cer, 1.5-7pf	
C35	0180-0059	C: fxd, elect, 10µf -10% +100%, 25 vdcw	
C36	0140-0145	C: var, 22pf ±5%, 500 vdcw	
C37	0180-0033	C: fxd, elect, 50µf, 6 vdcw	
C38	0180-0064	C: fxd, elect, 35µf -10% +100%, 6 vdcw	
C39		Same as C38	
C40	0180-0039	C: fxd, elect, 100µf, 12 vdcw	
C41		Same as C38	
C101	0180-0149	C: fxd, alum elect, 65µf, -10% +100%, 60 v	
CR1	1902-0054	Diode, Si:	
CR2	1910-0016	Diode, Ge:	
CR3	1901-0025	Diode, Si:	
CR4		Same as CR2	
CR5		Same as CR2	
CR6	1902-0072	Diode, Si: breakdown, 7.75 v ±.25 v, 400 MW	
CR7	1901-0027	Diode, Si:	
CR8		Same as CR7	
CR101	1901-0025	Diode, Si:	
CR102		Same as CR101	
CR103		Same as CR101	
CR104		Same as CR101	
CR105	G-29A-74	Diode, Si: breakdown	
CR106		Same as CR101	
L1	9140-0107	Indicator, coil fixed, 27µf ±10%	
Q1	1850-0071	Transistor 2N1516 (Selected)	
Q2	1850-0096	Transistor: Ge, 2N2189	
Q3	1850-0003	Transistor: 2N1516/OC170	
Q4	1854-0003	Transistor: Si	
Q5	1850-0062	Transistor	
Q6		Same as Q4	
Q7		Same as Q2	
Q101	1850-0064	Transistor: 2N1183	
R1	0683-1845	R: fxd, comp, 180K ohms ±5%, 1/4W	
R2	0687-2751	R: fxd, comp, 2.7M ohms ±10%, 1/2W	
R3	0687-5651	R: fxd, comp, 5.6M ohms ±10%, 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗ Stock No.	Description	Note
R4	0727-0095	R: fxd, dep carbon, 900 ohms ±1%, 1/2W	
R5		Same as R3	
R6		Same as R2	
R7		Not assigned	
R8	2100-0277	R: var, comp, 100 ohms ±20%, 0.3W	
R9	0687-2701	R: fxd, comp, 27 ohms ±10%, 1/2W	
R10A, B	2100-0276	R: var, lin, ww ±1%, 10K ohms, 1W	
R11		Same as R4	
R12		Not assigned	
R13	0687-1801	R: fxd, comp, 18 ohms ±10%, 1/2W	
R14		Same as R13	
R15	2100-0299	R: var, comp, lin, single 3000 ohms ±20%, .3W	
R16	0687-1031	R: fxd, comp, 10K ohms ±10%, 1/2W	
R17	0727-0112	R: fxd, dep, carbon, 1800 ohms ±1%, 1/2W	
R18	0686-2035	R: fxd, comp, 20K ohms ±5%, 1/2W	
R19	0686-3325	R: fxd, comp, 330 ohms ±5%, 1/2W	
R20	0687-3311	R: fxd, comp, 330 ohms ±10%, 1/2W	
R21	0686-6225	R: fxd, comp, 6200 ohms, ±5%, 1/2W	
R22	0687-4701	R: fxd, comp, 47 ohms ±10%, 1/2W	
R23	0727-0134	R: fxd, dep carbon, 4.4K ohms ±1%, 1/2W	
R24	0687-1201	R: fxd, comp, 12 ohms ±10%, 1/2W	
R25	0687-5601	R: fxd, comp, 56 ohms ±10%, 1/2W	
R26		Same as R25	
R27		Not assigned	
R28		Not assigned	
R29		Same as R22	
R30	0686-6215	R: fxd, comp, 620 ohms ±5%, 1/2W	
R31	0686-3605	R: fxd, comp, 35 ohms ±5%, 1/2W	
R32	0689-0001	R: fxd, comp, 4.7 ohms ±5%, 1/2W	
R33		Not assigned	
R34	0686-2015	R: fxd, comp, 200 ohms ±5%, 1/2W	
R35	0687-1011	R: fxd, comp, 100 ohms ±10%, 1/2W	
R36	2100-0108	R: var, comp, lin, 100 ohms ±30%, 1/3W	
R37	0687-1831	R: fxd, comp, 18K ohms ±10%, 1/2W	
R38		Same as R32	
R39		Same as R16	
R40A, B	2100-0447	R: var, bridged, 600 ohms ±20%, 2W	
R41	0686-6215	R: fxd, comp, 620 ohms ±5%, 1/2W	
R42		Same as R41	
R43	0758-0053	R: fxd, metallic oxide, 100K ±5%, 1/2W	
R44	0758-0006	R: fxd, metallic oxide, 10K ohms ±5%, 1/2W	
R45	2100-0182	R: var, comp, lin, 3.3K ±10%, 0.3W	
R46	0687-1041	R: fxd, comp,100K ohms ±10%, 1/2W	
R47	0687-4731	R: fxd, comp, 47 ohms ±10%, 1/2W	
R48	0687-3951	R: fxd, comp, 3.9M ohms ±10%, 1/2W	
R49	0687-1031	R: fxd, comp, 10K ohms ±10%, 1/2W	
R50 (208A)	0758-0069	R: fxd, metallic oxide, 1.1K ±5%, 1/2W	
R50 (208A-DB)	0758-0070	R: fxd, comp, 1.2K ohms ±10%, 1/2W	
R51	0684-3311	R: fxd, comp, 330 ohms ±10%, 1/4W	
R52	0687-1531	R: fxd, comp, 15K ohms ±10%, 1/2W	
R53		Not assigned	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	ⓗ Stock No.	Description	Note
R54		Not assigned	
R55	0766-0013	R: fxd, metallic oxide, 563 ohms ±2%, 3W	
R56		Same as R55	
R57	0766-0012	R: fxd, metallic oxide, 38 ohms ±2%, 3W	
R58*			
R59*			
R60	0766-0011	R: fxd, mfgl, 491 ohms ±2%, 3W	
R61		Same as R60	
R62	0766-0010	R: fxd, metallic oxide, 120 ohms ±2%, 3W	
R63*			
R64*			
R65	0766-0015	R: fxd, metallic oxide, 588 ohms ±2%, 3W	
R66		Same as R65	
R67	0766-0014	R: fxd, metallic oxide, 12 ohms ±2%, 3W	
R68*			
R69*			
R70	0766-0009	R: fxd, metallic oxide, 312 ohms ±2%, 3W	
R71		Same as R70	
R72	0766-0034	R: fxd, metallic oxide, 422 ohms ±2%, 3W	
R73*			
R74	0766-0039	R: fxd, metallic oxide, 255.5 ohms ±2%, 3W	
R75		Same as R74	
R76	0766-0040	R: fxd, metallic oxide, 573 ohms ±2%, 3W	
R77	0687-2741	R: fxd, comp, 270K ohms ±10%, 1/2W	
R78	2100-0095	R: var, comp, lin, 100K ohms ±30%, 1/5W	
R79	0687-1021	R: fxd, comp, 1000 ohms ±10%, 1/2W	
R80	0687-3331	R: fxd, comp, 33K ohms ±10%, 1/2W	
R81*			
R82*			
R83 thru R100		Not assigned	
R101	0758-0007	R: fxd, metallic oxide, 150 ohms ±5%, 1/2W	
R102	2100-0391	R: var, lin, 1K, ww ±20%, 1-1/4W	
R103	0686-4315	R: fxd, comp, 430 ohms ±5%, 1/2W	
R104		Same as R80	
R105	0687-3921	R: fxd, comp, 3.9K ±10%, 1/2W	
R106	0698-0001	R: fxd, comp, 4.7 ohms ±5%, 1/2W	
R107 thru R109		Not assigned	
R110	0766-0005	R: fxd, metallic oxide, 103 ohms ±2%, 3W	
R111		Same as R110	
R112	0766-0001	R: fxd, metallic oxide, 34.5 ohms ±2%, 3W	
R113		Same as R112	
R114	0766-0003	R: fxd, metallic oxide, 68.8 ohms ±2%, 3W	
R115		Same as R114	
R116	0766-0007	R: fxd, metallic oxide, 136 ohms ±2%, 3W	
R117		Same as R116	
R118	0766-0002	R: fxd, metallic oxide, 5.2K ohms ±2%, 3W	
R119	0766-0006	R: fxd, metallic oxide, 1.7K ohms ±2%, 3W	
R120	0766-0004	R: fxd, metallic oxide, 2.58K ohms ±2%, 3W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R121	0766-0008	R: fxd, metallic oxide, 1.26K ohms ±2%, 3W	
R122		Same as R70	
R123		Same as R70	
R124		Same as R65	
R125		Same as R65	
R126		Same as R60	
R127		Same as R60	
R128		Same as R55	
R129		Same as R72	
R130		Same as R67	
R131		Same as R62	
R132		Same as R57	
R133 thru R148		Not assigned	
R149		Same as R55	
S101	3101-0033	Switch-Slide: DPDT 115-230 v	
T101	9100-0172	Transformer-power	
		MISCELLANEOUS	
	G-74DA	Knob, red (208A)	
	353A-74A	Knob (208A-DB)	
	0370-0062	Knob, red, 3/4" (208A/208A-DB)	
	0370-0084	Knob, black (208A/208A-DB)	
	0370-0099	Knob, black (208A)	
	0370-0104	Knob (208A/208A-DB)	
	0370-0130	Knob (208A-DB)	
M1	1120-0151	Meter (208A)	
M1	1120-0153	Meter (208A-DB)	
DS-1	1450-0048	Light indicator	
	8120-0078	Power cord	
208A/208A-DB	00208-90000	Manual, Operating and Service	

See introduction to this section

Table 6-2. Replaceable Parts

ⓗ Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
G-74DA	Knob, red (208A)	28480	G-74DA	1	1		
G-29A-74	Diode, Si: breakdown	28480	G-29A-74	1	1		
353A-74	Knob (208A-DB)	28480	353A-74	1	1		
00208-61901	Range switch, Ae, includes: C1, 3, 4, 5, 6, 8 R1 R2, 3 R5, 6 S1	28480	00208-61901	1	1		
00208-63401	Ass'y, output attenuator (208A), A5, includes: R55 thru R57 R60 thru R62 R65 thru R67 R70 thru R72 R74 thru R76 S2	28480	00208-63401	1	1		
00208-66501	Ass'y, meter circuit board, A4, includes: C34 thru C40 CR7, 8 R43 thru R52 R77 thru R79 Q6, 7	28480	00208-66501	1	1		
00208-66502	Ass'y, power supply circuit board, A1, includes: C101 CR101 thru CR106 R101 thru R106 Q101 T101	28480	00208-66502	1	1		
00208-66503	Ass'y, circuit board, A2, includes: CR1 thru CR6 L1 Q1 thru Q5 R8, 9 R13, 14 R16 thru R21 R22 R23 thru R26 R29, 30 R32 R34 thru R36 R38	28480	00208-66503	1	1		
353A-34	Ass'y, output attenuator, A6, includes: R110, R149 S3, 4	28480	353A-34	1	1		
0130-0011	C: var, cer, 1.5-7pf	72982	557-023-COPO-102	1	1		
0130-0016	C: var, cer, 5-25pf, 500 vdcw	72982	557-019-COP-39R	1	1		
0130-0017	C: var, 8-50pf, 500 vdcw	72982	557-019-U2P0-34R	1	1		

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

ⓗⓟ Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
0140-0021	C: fxd, 39pf ±10%, 500 vdcw	00853	RCM15E390K	1	1		
0140-0100	C: fxd, 33pf ±5%	04062	RCM15E330J	1	1		
0140-0108	C: fxd, 253pf ±2%	14655	RCM15E(253)G	1	1		
0140-0145	C: var, 22pf ±5%, 500 vdcw	04062	DM15C220J	1	1		
0140-0172	C: fxd, 3000pf ±1%, 100 vdcw	obd#	DM19F302F	1	1		
0140-0173	C: fxd, 305pf ±1%, 100 vdcw	obd#	DM19F3050F	1	1		
0150-0042	C: fxd, titanium dioxide dielec, 4.7pf ±5%, 500 vdcw	28480	0150-0042	1	1		
0150-0055	C: fxd, titanium dioxide dielec, 10pf ±5%, 500 vdcw	78488	Type GA	1	1		
0150-0084	C: fxd, cer, dielec, .1μf +80% -20%	56289	33C41	1	1		
0150-0096	C: fxd, .05μf +80% -20%, 100 vdcw	94144	Type TA	3	2		
0170-0038	C: fxd, .22μf ±10%, 200 vdcw	56289	148P22492	1	1		
0170-0076	C: fxd, poly dielec, 3 sections, 3.05μf .305μf, .0305μf ±1% each	56289	111P	2	1		
0180-0033	C: fxd, elect, 50μf, 6 vdcw	56289	Type 30D133A1	1	1		
0180-0039	C: fxd, elect, 100μf, 12 vdcw	56289	30D154A1	1	1		
0180-0045	C: fxd, 20μf, 25 vdcw	56289	Type 30D	2	1		
0180-0059	C: fxd, elect, 10μf -10% +100%, 23 vdcw	56289	Type 30D182A1	1	1		
0180-0063	C: fxd, elect, 50μf -10% +100%, 3 vdcw	56289	30D120A1	1	1		
0180-0064	C: fxd, elect, 35μf -10% +100%, 6 vdcw	56289	30D132A1	2	1		
0180-0104	C: fxd, alum elect, 20μf, 15 vdcw	56289	30D174A1	2	1		
0180-0112	C: fxd, alum elect, 2000μf, 1 vdcw	56289	41D Type 497217	1	1		
0180-0140	C: fxd, alum elect, 300μf, 10 v	56289	4S608	1	1		
0180-0149	C: fxd, alum elect, 65μf -10% +100%, 60 v	56289	Type 30D	1	1		
0180-0155	C: fxd, 2μf ±20%, 25 vdcw	56289	D33258	1	1		
0370-0062	Knob, red, 3/4" (208A/208A-DB)	28480	0370-0062	1	1		
0370-0084	Knob, black (208A/208A-DB)	28480	0370-0084	1	1		
0370-0099	Knob, black (208A)	28480	0370-0099	1	1		
0370-0104	Knob (208A/208A-DB)	28480	0370-0104	1	1		
0683-1845	R: fxd, comp, 180K ohms ±5%, 1/4W	01121	CB1845	1	1		
0684-3311	R: fxd, comp, 330 ohms ±10%, 1/4W	01121	CB3311	1	1		
0686-2015	R: fxd, comp, 200 ohms ±5%, 1/2W	01121	EB2015	1	1		
0686-2035	R: fxd, comp, 20K ohms ±5%, 1/2W	01121	EB2035	1	1		
0686-3325	R: fxd, comp, 330 ohms ±5%, 1/2W	01121	EB3325	1	1		
0686-3605	R: fxd, comp, 35 ohms ±5%, 1/2W	01121	EB3605	1	1		
0686-6215	R: fxd, comp, 620 ohms ±5%, 1/2W	01121	EB6215	3	2		
0686-6225	R: fxd, comp, 6200 ohms ±5%, 1/2W	01121	EB6225	1	1		
0687-1011	R: fxd, comp, 100 ohms ±10%, 1/2W	01121	EB1011	1	1		
0687-1021	R: fxd, comp, 1000 ohms ±10%, 1/2W	01121	EB1021	1	1		
0687-1041	R: fxd, comp, 100K ohms ±10%, 1/2W	01121	EB1041	1	1		
0687-1031	R: fxd, comp, 10K ohms ±10%, 1/2W	01121	EB1031	2	1		
0687-1201	R: fxd, comp, 12 ohms ±10%, 1/2W	01121	EB1201	1	1		
0687-1531	R: fxd, comp, 15K ohms ±10%, 1/2W	01121	EB1531	1	1		
0687-1801	R: fxd, comp, 18 ohms ±10%, 1/2W	01121	EB1801	2	1		
0687-1831	R: fxd, comp, 18K ohms ±10%, 1/2W	01121	EB1831	1	1		
0687-2701	R: fxd, comp, 27 ohms ±10%, 1/2W	01121	EB2701	1	1		
0687-2741	R: fxd, comp, 270 ohms ±10%, 1/2W	01121	EB2741	1	1		
0687-2751	R: fxd, comp, 2.7M ohms ±10%, 1/2W	01121	EB2751	2	1		
0687-3311	R: fxd, comp, 330 ohms ±10%, 1/2W	01121	EB3311	1	1		

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

ⓗ Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
0687-3331	R: fxd, comp, 33K ohms ±10%, 1/2W	01121	EB3331	1	1		
0687-3921	R: fxd, comp, 3.9K ±10%, 1/2W	01121	EB3921	1	1		
0687-3951	R: fxd, comp, 3.9M ohms ±10%, 1/2W	01121	EB3951	2	1		
0687-4701	R: fxd, comp, 47 ohms ±10%, 1/2W	01121	EB4701	2	1		
0687-4731	R: fxd, comp, 47K ohms ±10%, 1/2W	01121	EB4731	1	1		
0687-5601	R: fxd, comp, 56 ohms ±10%, 1/2W	01121	EB5601	2	1		
0687-5651	R: fxd, comp, 56K ohms ±10%, 1/2W	01121	EB5651	1	1		
0689-0001	R: fxd, comp, 4.7 ohms ±5%, 1/2W	01121	EB47G5	3	2		
0727-0095	R: fxd, dep carbon, 900 ohms ±1%, 1/2W	19701	DC1/2C	2	1		
0727-0112	R: fxd, dep carbon, 1800 ohms ±1%, 1/2W	28480	0727-0112	1	1		
0727-0134	R: fxd, dep carbon, 4.44K ohms ±1%, 1/2W	28480	0727-0134	1	1		
0758-0006	R: fxd, metallic oxide, 10K ohms ±5%, 1/2W	07115	0758-0006	1	1		
0758-0007	R: fxd, metallic oxide, 150 ohms ±5%, 1/2W	28480	0758-0007	1	1		
0758-0053	R: fxd, metallic oxide, 100K ±5%, 1/2W	07115	C-20	1	1		
0758-0069	R: fxd, metallic oxide, 1.1K ±5%, 1/2W	07115	C-20	1	1		
0758-0070	R: fxd, comp, 1.2K ohms ±10%, 1/2W	07115	C-20	1	1		
0766-0001	R: fxd, metallic oxide, 34.5 ohms ±2%, 3W	07115	LPI-3	2	2		
0766-0002	R: fxd, metallic oxide, 5.2K ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0003	R: fxd, metallic oxide, 68.8 ohms ±2%, 3W	07115	LPI-3	2	2		
0766-0004	R: fxd, metallic oxide, 2.58K ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0005	R: fxd, metallic oxide, 103 ohms ±2%, 3W	07115	LPI-3	2	2		
0766-0006	R: fxd, metallic oxide, 1.7K ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0007	R: fxd, metallic oxide, 136 ohms ±2%, 3W	07115	LPI-3	2	2		
0766-0008	R: fxd, metallic oxide, 1.26K ohms	07115	LPI-3	1	1		
0766-0009	R: fxd, metallic oxide, 312 ohms ±2%, 3W	07115	LPI-3	2	1		
0766-0010	R: fxd, metallic oxide, 120 ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0011	R: fxd, mfgl, 491 ohms ±2%, 3W	07115	LPI-3	3	1		
0766-0012	R: fxd, metallic oxide, 38 ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0013	R: fxd, metallic oxide, 563 ohms ±2%, 3W	07115	LPI-3	2	1		
0766-0014	R: fxd, metallic oxide, 12 ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0015	R: fxd, metallic oxide, 588 ohms ±2%, 3W	07115	LPI-3	2	1		
0766-0034	R: fxd, metallic oxide, 422 ohms ±2%, 3W	07115	LPI-3	1	1		
0766-0039	R: fxd, metallic oxide, 255.5 ohms ±2%, 3W	07115	LPI-3	2	1		
0766-0040	R: fxd, metallic oxide, 573 ohms ±2%, 3W	07115	LPI-3	1	1		
1120-0151	Meter (208A)	28480	1120-0151	1	1		
1120-0153	Meter (208A-DB)	28480	1120-0153	1	1		
1450-0048	Light indicator	08717	858R	1	1		
1850-0003	Transistor: Ge, 2N1516/OC170	73445	2N1516/OC170	2	1		
1850-0062	Transistor: Ge	01295	GA287	1	1		
1850-0064	Transistor: Ge, 2N1183	86684	RCA 2N-1183	1	1		
1850-0071	Transistor: 2N1516 (Selected)	28480	1850-0071	1	1		
1850-0096	Transistor: Ge, 2N2189	01295	2N2189	2	1		
1854-0003	Transistor: Si	49956	RT5299	1	1		
1901-0025	Diode, Si:	03877	SG-817	6	5		
1901-0027	Diode, Si:	73293	HD5004	2	1		
1902-0054	Diode, Si:	28480	1902-0054	1	1		
1902-0072	Diode, Si: breakdown, 7.75 v ±.25 v, 400 MW	07910	CD34116	1	1		
1910-0016	Diode, Ge:	93332	D2361	3	2		

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

ⓗⓟ Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
2100-0095	R: var, comp, lin, 100K ohms ±30%, 1/5W	28480	2100-0095	1	1		
2100-0108	R: var, comp, lin, 100 ohms ±30%, 1/3W	71450	UPE-70	1	1		
2100-0182	R: var, comp, lin, 3.3K ±10%, 0.3W	71450	UPE-70	1	1		
2100-0276	R: var, lin, ww, 10K ohms ±1%, 1W	16688	10-42-1561	1	1		
2100-0277	R: var, comp, 100 ohms ±20%, 0.3W	11326	Type UPE65 CV	1	1		
2100-0299	R: var, comp, lin, single 3000 ohms ±20% .3W	71450	UPE-70	1	1		
2100-0391	R: var, lin, ww, 1K ±20%, 1.25W	11236	Series 110	1	1		
2100-0447	R: var, bridged, 600 ohms ±20%, 2W	73506	JJ89269	1	1		
8120-0078	Power cord	28480	8120-0078	1	1		
9100-0172	Transformer, power	06513	6-2249	1	1		
9140-0107	Indicator, coil fixed, 27μh ±10%	28480	9140-0107	1	1		
00208-90000	Manual, Operating and Service	28480	00208-90000	2	2		

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

CODE NO.	MANUFACTURER	ADDRESS
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Division	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire & Cable Company	Redwood City, Calif.
04870	P. M. Motor Co.	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05729	Metropolitan Telecommunications Corp., Metro Cap. Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronics, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronics, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C. A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71528	Standard-Thomson Corp., Clifford Mfg. Co. Div.	Waltham, Mass.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Products Co.	Chicago, Ill.

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H4-2 Dated: March 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J. H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C. W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91921	Minneapolis-Honeywell Regulator Co., Micro-Switch Division	Freeport, Ill.
92196	Universal Metal Products, Inc.	Bassett Puente, Calif.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

CODE NO.	MANUFACTURER	ADDRESS
0000F	Malco Tool and Die	Los Angeles, Calif.
0000I	Telefunken (c/o American Elite)	New York, N.Y.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000FF	Carmichael Corrugated Specialties	Richmond, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics,	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.

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H4-2 Dated: March 1962

WARRANTY

All our products are warranted against defects in material and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your hp field office for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges.* Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your hp field office is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

CUSTOMER SERVICE

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, U.S.A.
Telephone: (415) 326-3950
TWX No. PAL AL 117-U
Cable: "HEWPACK"

OR (In Western Europe)

Hewlett-Packard S.A.
54-54bis Route Des Acacias
Geneva, Switzerland
Telephone: (022) 42.81.50
Cable: "HEWPACKSA"

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